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Firefighters Guide

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ıtacting:

Boise Interagency Fire Center
3905 Vista Avenue
Boise, Idaho 83705

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FORWARD

This Firefighter's Guide contains revised and updated material previously found in the Forest Service Fireman's Handbook. The National Wildfire Coordinating Group, Fire Equipment Working Team, established a task group in 1985 to direct the development of this Guide, accomplished in 1986 with the assistance of a private contractor.

The task group consisted of:

Marvin Newell
USDA Forest Service
Boise Interagency Fire Center
Boise, ID

Gordon Stevens
USDA Forest Service (Ret.)
Boise, ID

Steve Raddatz
USDA Forest Service
Boise National Forest
Idaho City, ID

Ed Tarter
Idaho Department of Lands
Boise, ID

Marie Guise
Artist and Illustrator
Boise, ID

Gene Benedict
and District Fire Management Officers
Payette National Forest
McCall, ID

David B. Butts
USDI National Park Service
Boise Interagency Fire Center
Boise, ID

Bob Webber
USDI Bureau of Land Management
Boise Interagency Fire Center
Boise, ID

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ZERO CODE

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ZERO CODE

02 - OBJECTIVE. This publication is not a policy manual but is intended to be a basic source of knowledge for all firefighters, including lookouts and prevention people. It contains fire suppression basic information, such as fire weather and fire tactics, for use by individual firefighters or small crews in initial attack situations. Some information, such as map reading, is not found in other guides/handbooks. It also contains basic essentials from skills which are detailed in other references. For example, helicopters are considered here in terms of the firefighter's use only. They are discussed in greater detail in the Interagency Helicopter Handbook. Firefighters whose responsibilities require skills and knowledge beyond the scope of this guide should consult the handbook covering the specialty needed.

03 - POLICIES.

a. Forest Service. The objective of fire suppression is to suppress wildfires at minimum cost consistent with fire management direction and land and resource management objectives.

b. Bureau of Indian Affairs. Wildland fires, whether on lands administered by the Bureau or adjacent thereto, which threaten life, man-made structures, or are determined to be a threat to the natural resources or facilities under the Bureau's jurisdiction, will be considered emergencies and their suppression given priority over normal Bureau programs.

c. Bureau of Land Management. The suppression of wildfire, whether caused by lightning or human related ignition sources, is given priority over normal Bureau activities, except those involved in safeguarding human life.

d. Fish and Wildlife Service. The suppression of wildfire is given priority over other activities except for those involving the safeguarding of human life. The highest priority is given to the avoidance of disaster fires by aggressive prevention and suppression action.

e. National Park Service. The objective of fire suppression is to protect life and property, and to minimize the impact of wildfire and the suppression action on park resources.

f. State Forestry Organizations. State and local policies are varied and designed to meet local needs.

CHAPTER 10 - FIREFIGHTER'S JOB

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CHAPTER 10 - FIREFIGHTER'S JOB

There are many important tasks associated with the firefighter's job of prevention, detection, and suppression. A few of the more important ones are described.

Housekeeping and personal appearance are among the most important. The station and individual will reflect the only contact many forest visitors make with the agency when they visit the public lands. The impression they gain of your agency will be influenced by:

1. A clean, well kept station.

2. A clean, well maintained vehicle.

3. Your personal appearance.

4. Courteous treatment.

5. Correct information from you.

11 - PUBLIC RELATIONS. It is a tradition as well as policy to keep quarters neat, clean, and orderly. The same is true for personal appearance. Some may be required to wear an official uniform. Local instructions on this will be given by your supervisor.

You are a public servant whose employer is the public, which expects courteous treatment. You should learn the area in your responsibility. You should be well acquainted with agency regulations as they relate to the management of the lands under the jurisdiction of your agency.

The firefighter shares the responsibility for wildland fire protection during the period of employment. The job is generally confined to an important part of the public lands of the United States. Every acre is valuable and important. Some acreage will be used for many purposes. There is timber to be managed, grown, used, and protected; watersheds to be managed and protected to provide clean water in steady supply for agriculture, industry, and homes; forage to be grown so soils will stay where they are and provide feed for domestic livestock; wildlife habitats to be managed and improved so people may relax, stretch legs, fill lungs with good air, catch a fish, steer a boat, swim a lake, pitch a tent, or just loaf; natural beauty to be preserved and enhanced for everyone. It takes a sound planning, management and protection system to do all this. And it takes good people to apply it and protect from fire.

The management principles that guide your agency require that resources be managed harmoniously so the public lands provide a combination of uses to best serve the American people--and without harming the land's ability to produce--this is multiple use management.

A firefighter should be able to answer many pertinent questions. Information given should be accurate. If you do not know, you should say so. However, make all reasonable effort to obtain answers from your supervisor about local natural resource management, including fishing, hunting, camping, unusual natural features, fire activity, and your agency's responsibilities.

12 - WORKING WITH WEATHER. Some firefighters occupy stations that observe, record, and report weather. These people will receive special instructions.

Weather reported by observation stations is used to forecast and predict fire weather conditions.

The National Fire Danger Rating System will influence the firefighter's work. It includes weather observation and forecasts in predicting fire danger for the following day. Complete information is available in the National Fire Danger Rating System Handbook.

13 - TWENTY-FOUR-HOUR TIME. Twenty-four-hour time is standard for fire-management use. It will be used in preparing fire timeslips and all other fire-suppression records.

Under this system, the hours in a day are numbered in a single series of 24. The numbering begins and ends at midnight.

Four digits are used to indicate the time. The first two show the hours past midnight. The last two show the minutes past the hour.

Examples:

12-hour time	24-hour time
Midnight	2400
12:01 a.m.	0001
12:10 a.m.	0010
1:00 a.m.	0100
10:00 a.m.	1000
Noon	1200
1:00 p.m.	1300
6:00 p.m.	1800

14 - CARE OF STATION

14.1 - Opening Station. Before going to a station a firefighter gets special information on the job to be done.

14.2 - Maintaining Station. Daily maintenance is keeping the station neat and clean, with floors swept, beds made, dishes and windows washed, etc.

Besides these tasks there are annual painting jobs, stovepipe replacements, and minor repair jobs to do. The grounds must also be kept neat, clean, free from rubbish, and vegetation kept away from the buildings. What is needed in order to do these jobs should be determined soon after opening the station, and the information passed on to the individual's supervisor.

14.3 - Closing Station. Complete instructions on station closing will be issued locally. These will include drainage of water systems, storage of dishes and utensils, protection of bedding from rodents, and what to do with communication equipment. Also, information on closing and locking the buildings will be issued locally.

14.4 - Job Lists. Prepare a job list for each station and place it in the front of this guide. Accomplishments are shown by entering the date each job is completed or as otherwise instructed. Jobs done, but not included on the list, should be entered along with date completed. The wide-awake firefighter should have a number of these entries.

14.5 - Vehicle Maintenance. Your vehicle must always be kept ready to use. Check your vehicle each day to ensure proper oil level, tire pressure, engine coolant, etc. so that the vehicle is ready to use. Keep the windshield and windows, as well as the vehicle, clean and presentable. Use your agency checklists or standards for vehicle maintenance, safety and readiness so that you can safely travel to where you need to go.

15 - COMMUNICATIONS. Prompt, dependable communication is a necessary part of good fire management work. Some stations use radio, others use telephone. Some use both. Failure of the radio or telephone requires prompt investigation and repair by the responsible person. You should know what to check in case of communication failures and how to determine the reason for the failure. Check calls may be made to determine if the telephone or radio is working properly. If not, repairs can be promptly made before communication is needed for an emergency call, such as reporting a fire.

15.1 - Telephone. Some good telephone-use practices are:

1. Be courteous.

2. Announce yourself and your organization.

3. Take clear notes during conversations.

4. Do not leave someone on "hold" for more than a brief time. Get the information and call them back.

5. If others are using the line, hang up and wait until they are through, unless your message is of an emergency nature.

6. If you have an emergency message, break in on the conversation and ask to use the telephone.

7. Keep your conversations as brief as possible.

15.2 - Radio. Agency radios are to be used only for official business. Radio use is systematically monitored by the Federal Communications Commission. Always remember that many private citizens have radio receivers capable of receiving our transmissions. Most of our cooperators monitor our frequencies for informational purposes. Because of this, you should always be careful of the language used and refrain from making statements which might be embarrassing to you and your agency.

1. Good Radio Use Practices

   a. Always be courteous.

b. Use proper language. Swearing and obscene language are prohibited.

c. Answer radio call promptly.

d. Think through your message and make notes for yourself before starting to transmit.

e. Be brief. Radio channels are crowded. Use clear text and plain English.

f. Have pencil/pen and note paper available for taking notes/messages.

g. If others are using the frequency, wait until they are through unless your message is of an emergency nature.

h. If yours is an emergency message, break in on the conversation and ask for the air.

i. Pronounce your words distinctly.

j. Talk into the microphone.

k. Use normal tone of voice.

2. Message Procedure. Every effort possible should be made to use radios correctly. Correct use permits proper understanding of your message and results in prompt action. Delays mean loss of minutes, and minutes count in fire suppression work. The proper procedure in transmitting a message is as follows:

a. In transmitting messages, always give the call name or number of the station you are calling first, followed by your call name or number.

b. All messages must be brief and to the point. Pronounce words distinctly and rather slowly. Finish quickly--the air time may be needed for fire business. If possible, write your message first, then read it rather slowly and distinctly over the air. All lengthy messages should be written. The normal dispatch rate should be 40 to 60 words per minute.

c. Use the radio "clear text" words whenever possible, to brief your message.

d. When you are through transmitting (message given, and reply received) you should terminate the conversation by

giving your call name or number. This indicates the air is clear for communications by others.

3. Message Priorities. When radio traffic is exceptionally heavy, it is sometimes necessary to set priorities on the various calls to be relayed. These priorities are as follows:

a. Messages concerning medical aid.

b. Messages concerning fire suppression.

c. Messages concerning food, equipment, tool orders, and other such items.

d. Administrative business

4. Radio Troubleshooting. Radios are technical pieces of equipment which may get out of adjustment easily. For this reason, only qualified technicians are permitted to work on the set.

Each day you should make the assigned radio check calls to determine if your set is in working order. If you find it is not working properly, then check the following:

a. Battery. Check to determine that batteries have been installed correctly according to diagram furnished.

b. Antenna. See that antenna is properly connected.

c. General Trouble. Don't give up the first time. Try your call again. The station you are calling may not be on the air at the moment, or may be busy with other conversation you cannot hear. Some unusual atmospheric condition may be affecting reception, or conditions may be poor in the middle of the day and improve towards evening; try changing your location (if radio is not stationary); if you cannot get the station you want, try contacting another station and have them relay for you.

If the trouble is not corrected after these checks, notify your supervisor by telephone or other means; a qualified technician will be dispatched to work on the set.

5. Care of Hand-Carried Portables

a. Keep the radio in carrying case at all times.

b. Turn off switch when radio is not in use.

c. Protect the radio from moisture, excessive heat, dirt, crushing, sharp jars, and excessive vibration.

6. Radio Safety Hints

a. Due to the high voltage in certain circuits, only qualified technicians shall be allowed to work on radio equipment.

b. A radio transmitter shall not be used within 300 feet of electric blasting.

c. Do not carry electric blasting caps in radio-equipped cars or trucks.

d. When using car radio, driver shall slow down or preferably stop except during emergencies.

e. All whip antennas shall be equipped with safety knobs.

7. Lightning Storms. The following instructions should be posted near all radio equipment located in exposed structures:

a. When a lighting storm is more than 1 mile away, the radio receiver may be left operating, but touching the controls of the equipment should be avoided until the storm has passed.

b. When the storm is less than a mile away, it is desirable, although not essential, to shut off the master switch on the equipment.

Caution: Since shutting off the equipment requires touching the instrument panel, this should be done immediately following a local flash and the equipment avoided thereafter until the storm has passed.

16 - SAFETY. The firefighter's safety responsibilities include wearing of nonskid shoes; watching footing and handholds; watching for hazards such as blowups, snags, rolling logs or chunks, sliding or kick back snags, tops breaking off, or falling trees knocking down other trees; keeping a minimum of 6 feet apart while walking and 10 feet apart while working; passing burning or fire--weakened trees only on uphill side or above lean; and carrying tools, except crosscut saw, in hand. Carry crosscut saw on shoulder with teeth out and with guard over teeth. When carrying chain saws, stop saw before carrying. Point bar forward when going downhill and the saw is at your side. Point the bar to the rear when going uphill. Fasten a protective guard for bar and dogs when carrying saw on the shoulder.

Detailed safety aspects are taught in specific agency training courses such as for power saws, basic firefighter, engines, etc., and are not included in this guide.

16.1 - Accident Prevention. A good safety policy is that accident prevention is a most important part of any job. Safety must come first, even before production on any job--regular or emergency. No job should be considered so demanding that there is not time to do it safely.

Each firefighter should become familiar with safety instructions for the job. When a new type of work is started safety instructions should be studied first. If there are no instructions for the job to be done, you should seek safety guidance from your supervisor.

Since a firefighter may be working alone some of the time, it is extremely important to work safely and avoid injury.

If injured, an employee must report either in writing on appropriate form(s) or verbally, even though it is a minor injury. This should be done promptly, within 48 hours. For more details see your agency instructions.

16.2 - Personal Health - Maintenance and Prevention. Personal health is important in getting each job done safely. Maintain a well-balanced diet. Take time to eat nutritious food. Drink enough water to avoid dehydration. Keep fit and trim by regular exercise and/or work. Provide for adequate sleep needs. Fire suppression work is demanding and requires top physical conditioning.

1. Heat Stress. Appendix A describes Heat Stress. Refer to it for detailed knowledge of what Heat Stress can do to you, how to prevent it, and how to treat it.

2. Preventing and Treating Poison Ivy and Poison Oak. Appendix B describes these common poisonous plants, how they poison, prevention measures, and treatment should you come in contact with the plants or their poison.

16.3 - Personal Protective Equipment. The components may include:

Fire shelter
Hard hat
Flame resistant shirt and jeans
Flame resistant gloves, and leather boots

Your agency may require you to carry a fire shelter with you whenever engaged in fire suppression line work or prescribed

burning. The shelter must be regarded as a last resort only. No action should be taken that relies on the shelter for protection.

1. Personal Protective Equipment. Appendix C describes the clothing and equipment designed for your protection. Consult it for information and guidelines in use.

2. Your Fire Shelter. Appendix D contains information on care and use of your fire shelter. You should study the material well enough to know instinctively how to deploy the shelter.

16.4 - Carbon Monoxide. Firefighters should be aware of potential hazards of carbon monoxide (CO) and how to avoid or minimize exposure to it. Appendix E describes the colorless and odorless gas, when it may accumulate, its affects, how to avoid it, and how to treat for exposure to the gas.

16.5 - First Aid. Some agencies require that all supervisory personnel, either seasonal or regular, who may be called upon to aid injured employees or citizens shall have first aid training and that their knowledge shall be kept current by refresher courses.

To help with first aid, each employee should have a copy of the American Red Cross First Aid Book. Each employee is expected to become familiar with these instructions.

CHAPTER 20 - FIRE PREVENTION

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CHAPTER 20 - FIRE PREVENTION

20.2 - Objective. The objective of fire prevention is to minimize damage from wildfires by preventing person-caused fires. Generally, all person-caused fires are preventable.

20.3 - Policy. Prevention of fires is a high priority job for all fire personnel.

20.4 - Firefighter's Responsibility. The statement of fire prevention policy emphasizes how important this activity is. The public will be contacted frequently. Every opportunity will be taken to promote fire prevention. To achieve the stated objective, you must cultivate friendly relationships and promote a cooperative spirit among forest users in preventing forest fires. This is an important public relations job.

Many wildland fires start from human carelessness. Fires which result from people's acts or are caused by human carelessness or maliciousness are termed "person-caused fires."

The largest group of forest users to be contacted are hunters, firewood cutters, fishermen, berrypickers, sightseers, and other recreationists. This group is responsible for more than 65 percent of person-caused fires. One of the most effective approaches is to talk with them personally about fire prevention.

Casual meetings or discussions are not sufficient. The best approach is by planned, systematic, personal contact. The following are points to remember:

1. Relate each message to the management and enjoyment of the land. Concentrate on the hows--how to put out a fire, how to report it, how to smoke safely, etc.

2. Most people do not want to start fires. Nearly everyone talked with should be made to believe they can have a part in preventing them. Use an approach which gives the visitor or forest user credit for helping in fire prevention.

3. Every contact is important. Success in making prevention contacts depends on ability to vary approach or conversation to meet many situations.

4. Develop friendships. Have a sincere interest in people, be friendly and enthusiastic in meeting or greeting people, make an effort to remember names, and be a good listener.

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To do a good job of fire prevention, you must know something about how fires start and who starts them.

<u>21</u> - <u>HAZARDS AND RISKS</u>. Person-caused fires are the result of a combination of hazards and risks.

1. A hazard is any burnable material. Some hazards, such as trash, rags, paints, and slash, are the result of our activities. Others are natural, such as dry grass, pine needles, and dead and felled trees. Some hazards such as dry grass and leaves are more dangerous than others. If there is a great deal of dry fuel in one place, the hazard is referred to as being high.

2. Risks are those things which cause fires to start. Examples of risks are matches in the hands of children, hot ashes, sparks from chimney flues, burning dumps, a person smoking, logging operations, hikers, road-maintenance crews, hunters, railroads, landowners burning brush and debris, and people setting fires intentionally.

3. Records show some person-caused fires are caused by forest residents and local people who work in the forest. Others are caused by visitors from more distant places. When risks and hazards are combined, the result is sometimes a fire. The firefighter's job is to prevent fires by either:

    a. Removing the hazard.

    b. Controlling the risk.

<u>21.1</u> - <u>Working with Hazards and Risks</u>. The following illustrations (figures 1 through 32) will help in recognizing some of the dangerous combinations of hazards and risks which may cause a fire. They also show how these same hazards and risks can be treated to prevent a fire.

FIRE POTENTIAL

Figure 1.--Smoking while traveling.

Glowing tip knocked off cigarette into flashy fuels.

FIRE PREVENTION

Figure 2.--Stopping to smoke in safe area.

All hot material falls onto bare ground in cleared area.

FIRE POTENTIAL

Figure 3.--Smoking in unsafe area.

Head flies off match into dry grass.

FIRE PREVENTION

Figure 4.--Smoking in safe area.

Hot material would fall on barren gravel bar.

FIRE POTENTIAL

Figure 5.--Grinding out cigarette butt in dry punky log.

Sparks can start fire easily on rotten wood.

FIRE PREVENTION

Figure 6.--Grinding out cigarette butt on flat rock in cleared area.

FIRE POTENTIAL

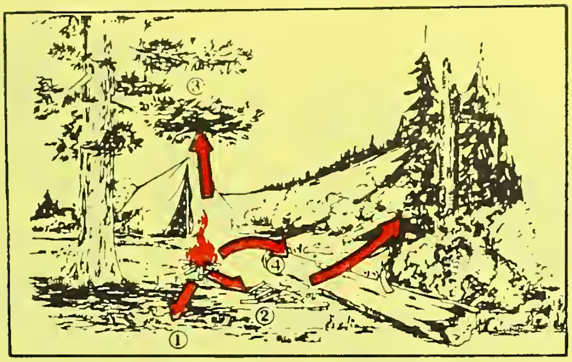


Figure 7.--Dangerous campfire.

Fire can escape:

1. In any direction by creeping through uncleared duff.
2. Into the woodpile and up the slope.
3. By spreading to branch too close to fire.
4. By spark igniting punky log.

FIRE PREVENTION

Figure 8.--Safe campfire.

1. Flammable ground cover cleared to mineral soil 5 feet in all directions from fire.

2. Woodpile away from fire on windward side.

3. Fire kept small as possible.

4. Fire built away from dangers such as steep slopes, rotten logs, trees, and overhanging branches.

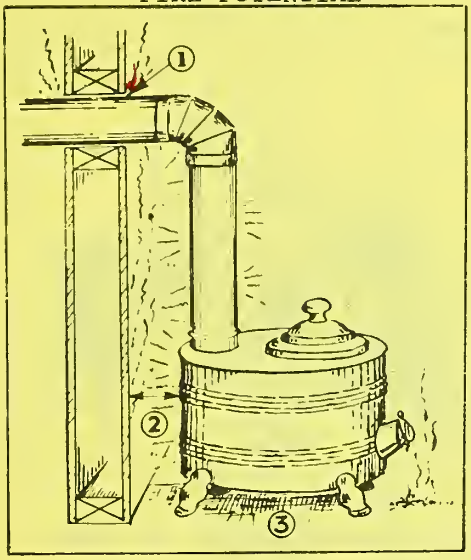
FIRE POTENTIAL

Figure 9.--Unsafe placement of campground stove under tree--
Inadequate clearing and cleanup.

FIRE PREVENTION

Figure 10.--Stove in safe place away from tree and area
cleaned around it. Now a safe camp.

FIRE POTENTIAL



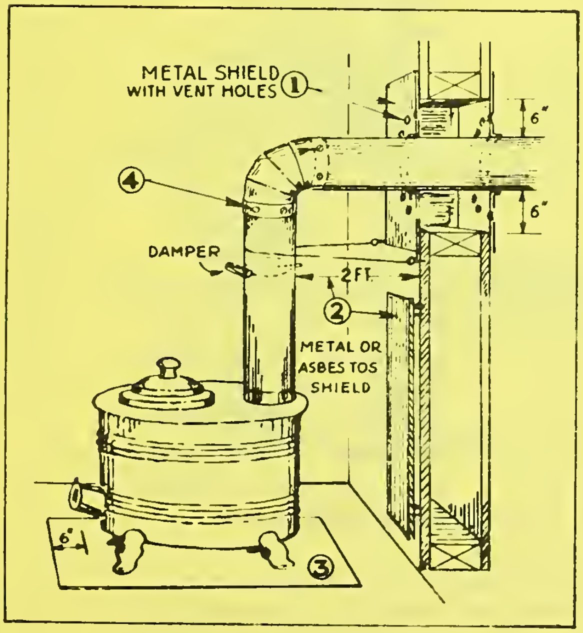
1. Stovepipe through wall (or ceiling) without adequate clearance and insulation.

2. Stove placed too close to wall without shield.

3. Stove too close to wooden floor without shield.

Figure 11.--Improper stove installation.

FIRE PREVENTION



1. Stovepipe out from wall and insulated where it goes through wall (or ceiling). Factory-built fireplaces shall be listed and shall be installed in accordance with the manufacturer's instructions.

2. Stove out from wall. Wall shielded with metal or other approved material, with airspace between shield and wall. Follow manufacturer's listing.

3. Heat resistant material on floor underneath stove. Hearth extensions shall be provided in accordance with manufacturer's instructions.

4. Stovepipe held together with metal screws.

Figure 12.--Proper stove installation.

FIRE POTENTIAL

Old rags, newspapers, and paint left around indiscriminately--gasoline can tipped over, spilling gasoline. Sun shining through bottle onto flammable materials.

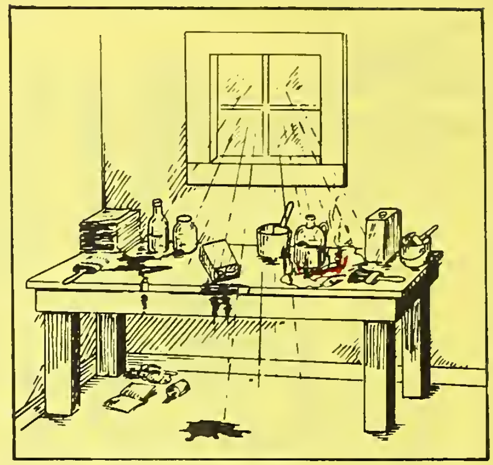


Figure 13.--Improper storage of paint, oily rags, and other flammable materials.

FIRE PREVENTION

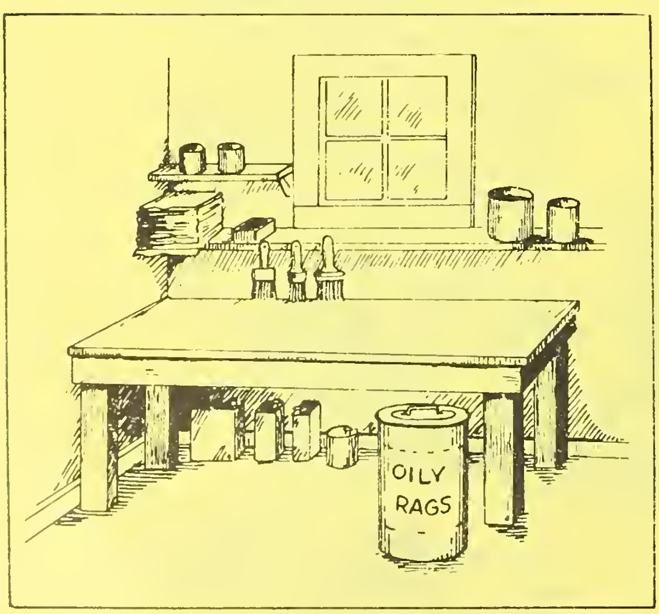


Figure 14.--Safe storage of flammable materials.

Old rags stored temporarily in metal pail in a well ventilated place (and burned frequently in a safe place). Papers neatly stacked on shelf. Gasoline and paint stored separately from rags. Spilled gas or oil wiped up frequently. Bottles should be stored in the shade. Cans are safer than bottles for storing inflammables.

FIRE POTENTIAL

Figure 15.--Unsafe chimneys and roof.

Sparks from stovepipe may ignite needles and leaves accumulated on roof.

FIRE PREVENTION

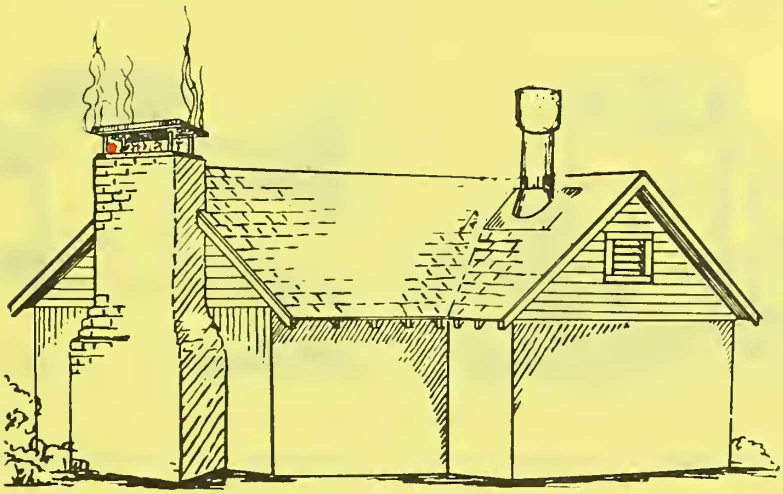


Figure 16.--Safe chimneys and roofs.

Arrester should be twice area of chimney and constructed of corrosion resistant material of not less than 14 guage--mesh not to be over 5/8 inches or less than 5/16 inches.

Needles or leaves cleared off. Stovepipe guyed and fastened with screws. Stovepipe provided with approved spark arrester.

FIRE POTENTIAL

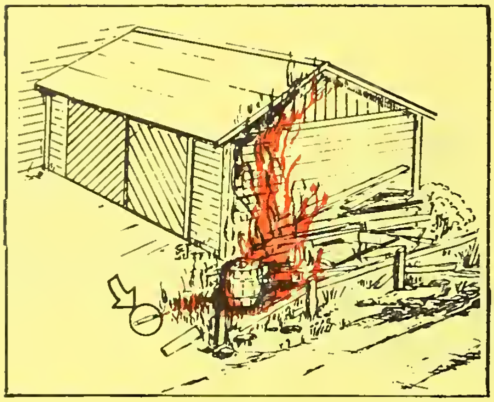


Figure 17.--Flammable material around building.

A fire starting in grass can easily spread to a woodpile and building. A fire starting in building can easily spread to surrounding area.

FIRE PREVENTION

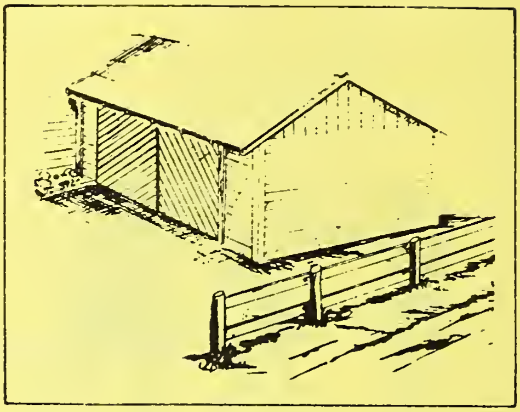


Figure 18.--Flammable material around building has been removed.

Fire goes out or can be stopped before reaching building. A fire starting in the building can be kept from spreading to surrounding area.

FIRE POTENTIAL

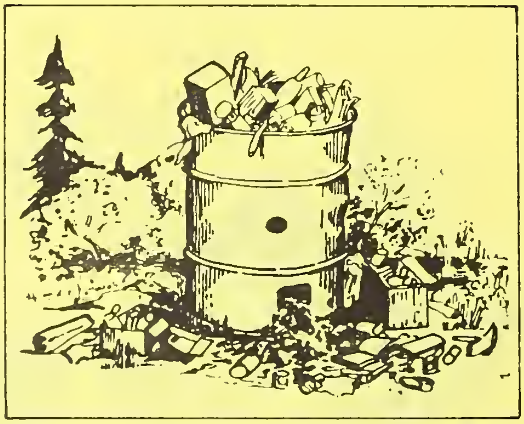


Figure 19.--Unsafe incinerator.

Area not cleared of flammable vegetation. Incinerator not fireproof--opening at top not screened. Debris allowed to accumulate (this fault may make even a safe installation dangerous).

FIRE PREVENTION

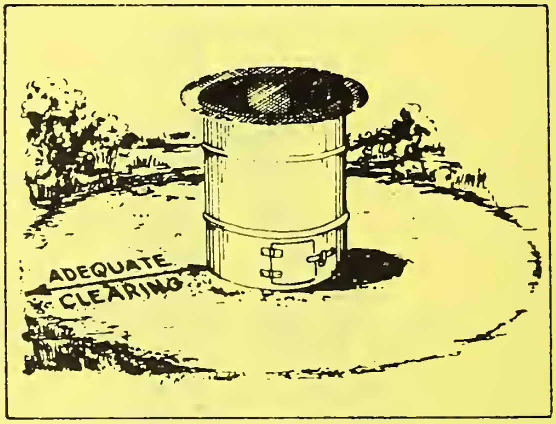


Figure 20.--Safe incinerator.

Area cleaned up. Adequate clearance of grass and weeds. Top screened with heavy screen with not more than 5/8-inch mesh or less than 5/16-inch to prevent escape of fire. Debris burned currently. Someone present with a bucket full of water, water hose or backpack pump while burning is done.

FIRE POTENTIAL

Figure 21.--Unsafe garbage disposal.

Garbage often contains flammable material which may be ignited by hot ashes, spontaneous ignition, or sunlight shining through glass. Fire can spread to grass and dry weeds at foot of brushy hill.

FIRE PREVENTION

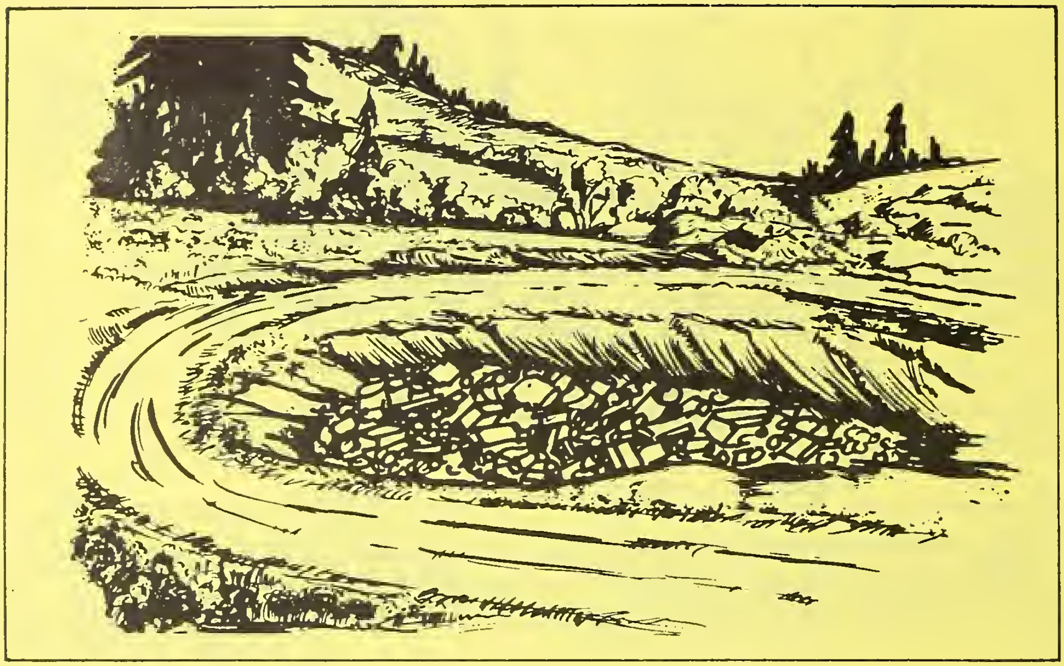


Figure 22.--Landfill and/or garbage disposal.

Area has a road or firebreak around it. Flammable material has been cleared up to the road or firebreak. Additional firebreaks should be constructed paralleling the roadside opposite the dump to provide the necessary fireproofing for varying conditions. If fire should start it will be contained within these firebreaks.

Open garbage pits and dumps are rare now. Most local regulations require waste material to be hauled to a designated landfill.

FIRE POTENTIAL

Figure 23.--Unsafe burning of debris.

No clearing between burning pile and timbered area.

FIRE PREVENTION

Figure 24.--Safe burning of debris.

Debris is burned in cleared area in an opening. Someone attends fire with firefighting equipment.

FIRE POTENTIAL

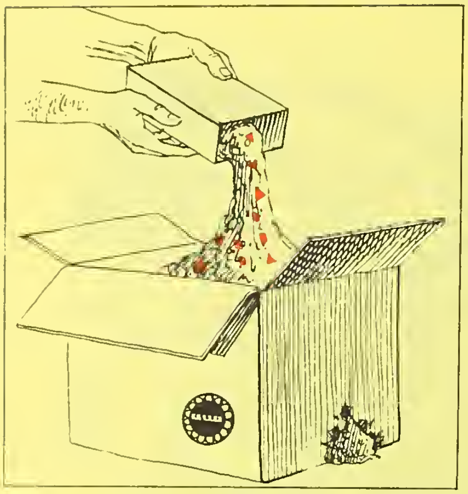


Figure 25.--Unsafe disposal of hot ashes.

Ashes dumped directly into cardboard box. Fire can spread in leaves, grass, and needles.

FIRE PREVENTION

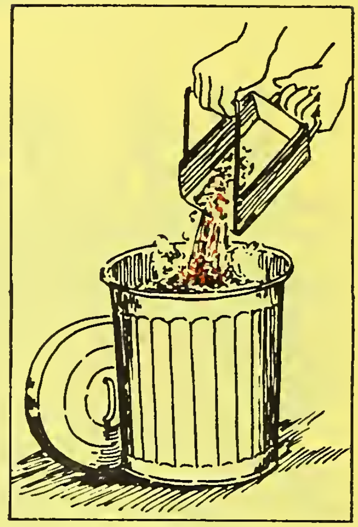


Figure 26. Safe disposal of hot ashes.

Cool ashes in covered metal container before dumping.

FIRE POTENTIAL

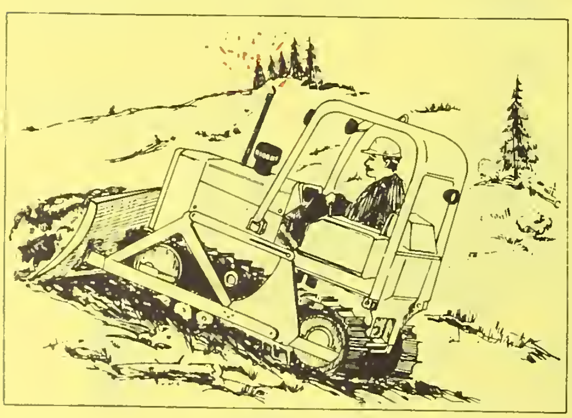


Figure 27.--Tractor without spark arrester.

Sparks land in grass, leaves or pine needles, starting fire.

FIRE PREVENTION

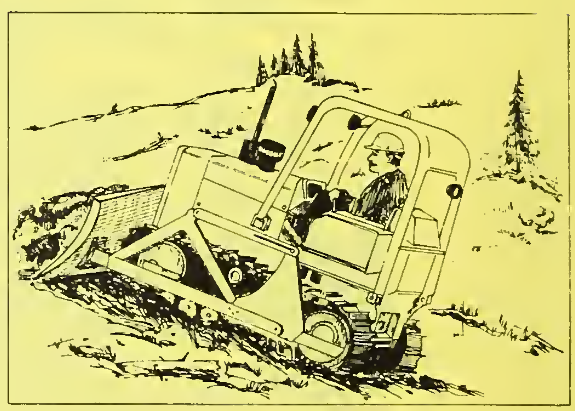


Figure 28.--Tractor with approved spark arrester installed.

Hot carbon is trapped in spark arrester--does not get out.

FIRE POTENTIAL

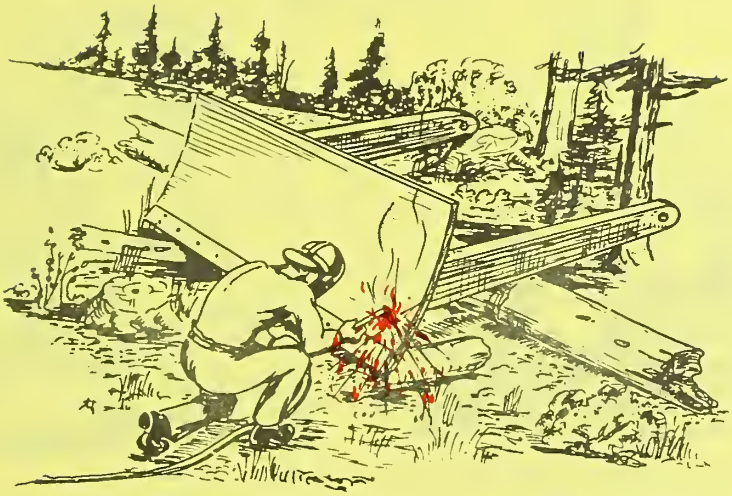


Figure 29.--Welding without regard for nearby flammable vegetation.

Sparks fall in flammable vegetation or punky log and may start fire.

FIRE PREVENTION

Figure 30.--Welder selects a clear area or clears an area.

Sparks and hot metal land on barren soil where they cannot start a fire. Shovel and backpack pump filled with water kept at hand in case a fire starts.

FIRE POTENTIAL

Figure 31.--Filling saw dangerously.

Saw is hot. Gasoline runs over and starts a fire. Saw being filled in unsafe location in midst of flammable material. No spark arrester.

FIRE PREVENTION

Figure 32.--Filling saw safely.

Saw being filled while cold. Care taken not to spill gasoline. Saw being filled in roadway or other cleared area free of slash, needles, duff, and other flammable materials. Saw should be started at least 10 feet from filling area. Equipped with an approved spark arrester.

21.2 - Removing Hazards. Removal of each hazard is likely to require a different approach. Some may be eliminated by persuading the person responsible that personal safety, as well as duty to others, requires discontinuing the dangerous practice; for example, cabin hazards. Others may be eliminated if the firefighter courteously explains that the law requires their removal. Hazardous camping places which, if left as they are, may be used again, should be eliminated. In handling hazard problems, such as sawmill waste disposal, firefighters may need the assistance of the Fire Management Officer.

It is important that each firefighter have a thorough knowledge of what constitutes a hazard; what kind of reduction or removal is proper and legal; what Federal and State laws apply. For example, such hazards as slash left by timber harvest or road right-of-way

clearing may be disposed of by burning. Firefighters should know under what conditions this should be considered, when it should be done, permits required, and laws governing. This information can be obtained from the agency office.

21.3 - Controlling Risk. Risk in fire prevention is related to people who visit or use the area. The firefighter's job is to get these people to do the right things. Controlling risk is an important fire prevention job. The rules for good public relations apply. There are several ways of approaching the task.

22 - EDUCATION. The most widely used approach is education of forest users by means of such materials as the cooperative forest fire prevention program's Smokey Bear handouts; fire prevention posters; and news releases on laws, closures, and fire danger situations. Another is personal contact. Different risks require widely different approaches.

1. Personal Contact. This is one of the firefighter's most effective prevention jobs. To work effectively with a logger, something must be known about the logging business. Personal acquaintance is important. Working with the camper will require a different approach. The important thing to remember is that each contact should be well planned. Know what should be talked about and how to approach the subject. See also 20.4 for some important points to remember.

2. Closures. Another way of preventing fire is through closures. This is keeping the risk away from high hazard areas during critical periods. Formal closures are proclaimed by the Governor or the agency head. The firefighter's responsibility may include tactful enforcement of such a closure.

3. Handouts. Smokey Bear handouts are examples of mass media material used in an educational program. The handouts are useful tools for personal contacts. The cooperative forest fire prevention program uses mass communications and advertising techniques to convince the general public that wildfires should be prevented. Program materials are distributed widely by Federal and State forestry agencies. The fire management officer will provide handout items. These should be displayed in an attractive and prominent manner at your headquarters.

23 - LAW ENFORCEMENT. When other prevention efforts fail, it is sometimes necessary to resort to law enforcement. The primary objective of fire law enforcement is to prevent or eliminate fire trespass. It is also important to obtain compensation for loss or damage suffered by the land management agency.

Letters of instruction provided to each firefighter will specify the appropriate law enforcement authority.

23.1 - Laws and Regulations

1. Fire law enforcement is based on Federal fire laws, regulations of the Secretaries of Agriculture or Interior, State fire laws, and county fire ordinances.

2. Fire trespass will be prevented on public lands through adequate administration, supervision, and publicity by all land managers. Law enforcement is one tool of fire prevention.

Aggressive action will be taken to discover, investigate, and report on all fire trespass involving public lands. Investigation will be continued until identity and responsibility of the trespasser is clearly established or until every reasonable means of fixing responsibility has been exhausted.

3. The trespasser will be brought to account, through legal procedures: (1) by a claim for compensation for damages; and (2) by appropriate criminal action for violating laws or regulations affecting the public lands.

4. Investigation and prosecution of trespass will have priority second only to suppressing the fire. Both will be effected simultaneously whenever possible.

Federal, State, county, and city law officers are generally willing to assist land managers in law enforcement to the extent possible without interference with their assigned duties. Some agencies have cooperative agreements that provide for support of county sheriffs.

23.2 - Legal Action. The agency will initiate action leading to court prosecution when evidence is sufficient to support a charge of violation of applicable Federal or State laws or regulations. Violations of State laws and county and city ordinances are handled in State, county, or city courts having jurisdiction. Violation of Federal laws and regulations are prosecuted only in Federal courts.

23.3 - United States Commissioners. United States commissioners specially designated by the court by which they were appointed may try and sentence persons charged with violations of Federal regulations related to the protection, occupancy, and use of public land.

23.4 - Misdemeanors. Most of the offenses, or violations, with which you will be concerned are classed as misdemeanors.

Violations of Federal fire regulations (with the exception of the closure regulations) are generally misdemeanors. They are punishable by a maximum fine of $1,000 or by imprisonment not exceeding 1 year, or both. (Violation of the regulation on forest closures is a petty offense with a maximum fine of $500.)

Violations of most State fire laws and county ordinances are generally misdemeanors and are punishable by a maximum fine of $500 or by imprisonment in a county jail not to exceed 6 months, or both.

Examples of misdemeanors are leaving a campfire unattended, smoking in a closed area, and burning without a permit.

<ins>23.5</ins> - <ins>Felonies</ins>. Felonies are more serious offenses and carry greater penalties. They are punishable by imprisonment in a State or Federal prison for terms exceeding 1 year.

A firefighter having occasion to participate in the investigation of a felony violation must get the advice of the line officer or Fire Management Officer.

Trained law-enforcement officers are available to assist in the action. The firefighter's job in this case is to obtain all information possible.

Violations of some of the Federal fire laws and a few of the State fire laws are felonies.

Examples of felonies are willful setting of fires on Federal land (violating a Federal fire law) and setting fire to a building with intent to destroy (violating a State fire law).

<ins>23.6</ins> - <ins>Firefighter's Action in Connection with Violations</ins>. If the firefighter has witnessed a violation, or a person has admitted an offense, the next action should be to write down the person's story of what happened just as it is told. Prepare a statement, which will include identification of violator, where violation occurred, and a detailed description of offense. Obtain the violator's signature on the statement if possible. Get location/address in case of further questioning, and report the matter without delay to your supervisor. If the violators are reluctant to sign a formalized statement, they might be persuaded to sign the original story as recorded by the firefighter.

If the violator refuses to sign or to remain available, the firefighter should report the incident immediately, and follow instructions concerning additional action.

If description of the people, clothing, car, and equipment are complete, this information will be helpful in locating the party later.

23.7 - Collection of Evidence. En route to the fire, make note of anyone suspected of having had something to do with starting the fire. Record license number and description of automobile, number of people and personal descriptions; look for tracks or other clues (foot, horse, or automobile) in the vicinity of the fire. Preserve and protect clues in place if possible for future reference; and protect tracks by blocking off or covering with logs, brush, or limbs (figure 1). In many areas where person-caused fires are a problem, the firefighter's work will be followed by another individual, such as a skilled investigator.

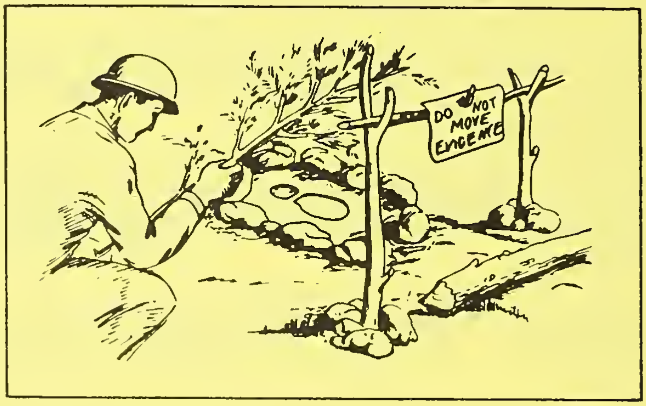


Figure 1.--Protecting evidence.

As the vicinity of the fire is approached, determine point of origin from wind direction and direction the fire has spread, cover any tracks in vicinity of point of origin, and keep other firefighters away from point of origin except where necessary for control of fire. A good protection method is to place plastic flagging around the area of origin. A guard may be necessary. Post signs if needed.

As attack is made, keep on the lookout for evidence of how fire started and who was responsible. Examples of evidence are campfire remains, matches, cigarette butts, lunch remains, scraps of paper, newspaper, bottles, and store receipts (or anything indicating identity of individuals). If evidence is found that looks important, try to get word to dispatcher as soon as possible. Protect any evidence found when it becomes necessary to move it. Handle each item carefully in order not to destroy fingerprints.

After the fire is controlled, or earlier if possible, look for and collect clues, being careful to preserve any item that may be used as evidence. If small, place it in matchbox or envelope. Record time and place found, and put your initials on the evidence or on container.

Prepare a map of the fire area, showing point of origin and locations of clues found.

Record any information obtained, names of anyone seen or contacted, and any conversations.

Obtain statements from witness or any other individual who may be connected in any way. These statements need not be elaborate. They should be complete as to detail, and should be obtained as soon as possible. If the statement is obtained at the scene of the fire, it would be handwritten on a piece of notebook paper.

FIREFIGHTERS GUIDE

CHAPTER 30 - PRESUPPRESSION

Contents

CHAPTER 30 - PRESUPPRESSION

This is the work done before fires occur to ensure that the fire force is ready to take fast, effective detection and suppression action on any and all fires. It includes hiring and training personnel, planning the organization, maintaining equipment and fire control improvements, and procuring equipment and supplies.

Effective initial attack action on fires is not accomplished by accident. It is the result of advance preparation of fire forces that are well trained, in top physical condition and ready to go at a moment's notice. Fast action requires that the firefighter:

1. Have your fire gear ready at all times.

2. Know exactly where you are going and how to get there.

3. Get there quickly and safely with the right equipment.

4. Hit fires hard while small.

31 - SMOKE CHASING

31.1 - Elapsed Time Standards. In all fire control work, speed--with safety--is essential. Generally, the longer a fire burns, the larger the fire becomes. Consequently, the job of controlling it becomes more difficult. Every job in fire control must be done in as short a period of time as possible. Fires should be discovered as soon as possible, attacked as early as possible, and controlled as quickly as possible.

Goals have been set for the maximum amount of time allowable for each step of the fire suppression job. These goals are elapsed time standards. Those established for initial attack forces are as follows:

1. Discovery

   As soon as possible.

2. Report to Dispatcher

   a. Radio 2 minutes

   b. Telephone 5 minutes

3. Report From Dispatcher to Fire Crew

a.	Radio	2 minutes
b.	Telephone	5 minutes

4. Getaway

		Day	Night
a.	Foot or vehicle	2 minutes	5 minutes
b.	Helicopter	10 minutes	-
c.	Saddle horse	5 minutes	10 minutes
d.	Packhorse	10 minutes	20 minutes

5. Travel Standards

a. Motor Vehicle. Drive at speeds which permit full control of the motor vehicle at all times. Do not exceed state or city speed limits.

b. Foot and Horse Travel. Travel continuously. At night travel as far as possible until too dangerous to travel even with lights, then start again at daylight.

31.2 - Firefighter's Physical Condition. Each person will do a better fire job when in top physical condition. It is necessary to eat adequate, wholesome meals regularly; keep regular sleeping hours; and develop physical stamina through hard work and/or an aerobic exercise program.

Many agencies have adopted an aerobic capacity physical fitness test. One is commonly called the "step test"; there are other methods. The test predicts the maximal ability to take in, transport, and utilize oxygen, the maximal oxygen intake or aerobic capacity--the best measure of physical fitness. Required fitness levels depend on agency and type of job. For more information, see: Wildland Fire Qualification Guide 310-1 and NWCG Fireline Handbook 410-1.

31.3 - Firefighter's Tools and Equipment. Firefighters must keep fire handtools, emergency rations, headlamp, canteen, clothing, fire shelter, and first aid gear packed and properly stored, ready for immediate use.

Transportation equipment must be serviced and ready to use. After each trip, vehicles should be refueled, checked, and parked ready

to use. Keep all engines and equipment in top condition--clean, inspected daily, complete with all accessories, and ready for immediate call.

Special fire tools, firing equipment, portable pumps, and portable radios are to be in top condition, complete, properly marked, ready for immediate dispatch to fire.

31.4 - Firefighter's Personal Gear. A firefighter will have personal gear and special clothing as needed to do the fire job. See Appendix A for more information. A fire bag will be kept ready at all times to include:

A change of trousers, shirt, and underwear.

Several changes of clean work socks.

Leather nonskid, high-top laced boots in good repair.

A warm, rugged jacket.

A well-fitted hard hat.

Leather gloves.

Toilet articles, including towel, soap, toothbrush, etc.

Sleeping bag.)
) when required
Firefighter's carrying case, complete.)

Also carry, at all times, a watch, pocketknife, and safety matches.

32 - MAP READING. The use of a map for locating fires requires some knowledge of the system of the public land survey. In many areas, land is subdivided into rectangular tracts, and a knowledge of this system enables you to refer to or find blocks of land in the mountains as simply as you find or refer to city blocks by the street names and numbers. In the East, metes-and-bounds surveys often complicate land-ownership patterns.

32.1 - Township Subdivisions. Land is divided by cardinal lines (lines which run due north, south, east, or west) into townships which are approximately 6 miles square (figure 1).

The townships are divided by cardinal lines into sections, each normally 1 mile square (figure 2). Townships and sections are often smaller or larger where survey corrections are made (figure 3).

The acre is the standard unit of area. One acre equals 10 square chains or 43,560 square feet and there are 640 acres in a regular section.

Example: The section is 1 mile square; that is, 80 chains by 80 chains, or 6,400 square chains. Point off one place to divide by 10, and the result is 640 acres.

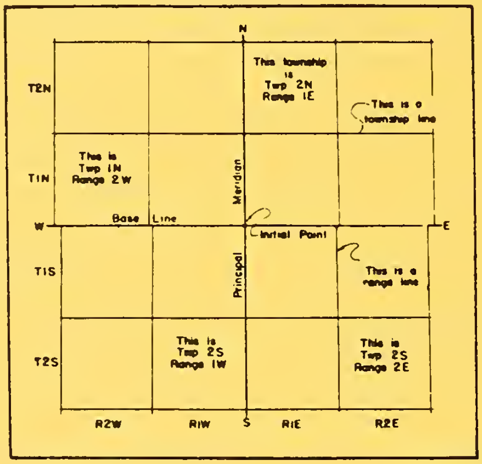


Figure 1.--System of referencing townships.

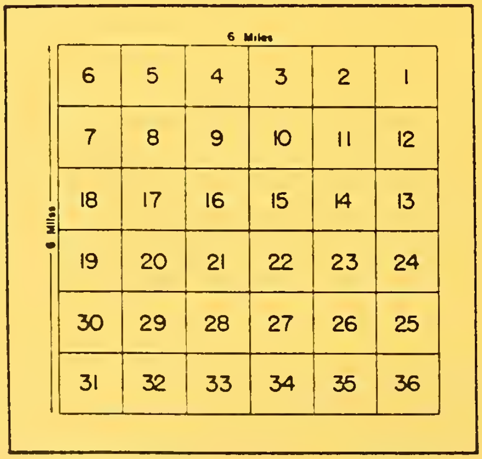


Figure 2.--Numbering sections within townships.

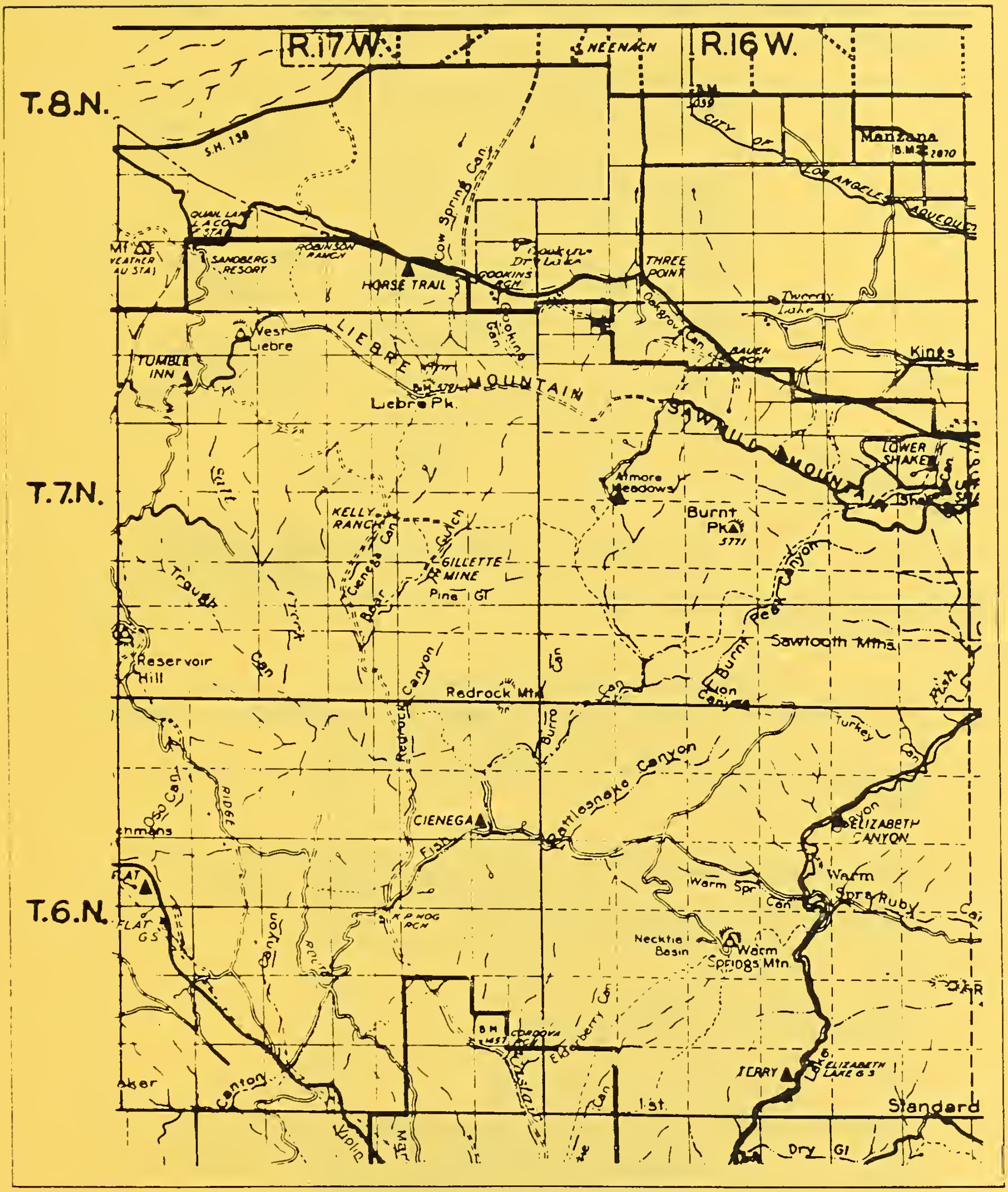


Figure 3.--Map showing arrangement of townships, ranges, and sections under general land survey.

32.2 - Section Subdivisions. The section is divided into quarter sections (which are not shown on field maps), as shown in figure 1.

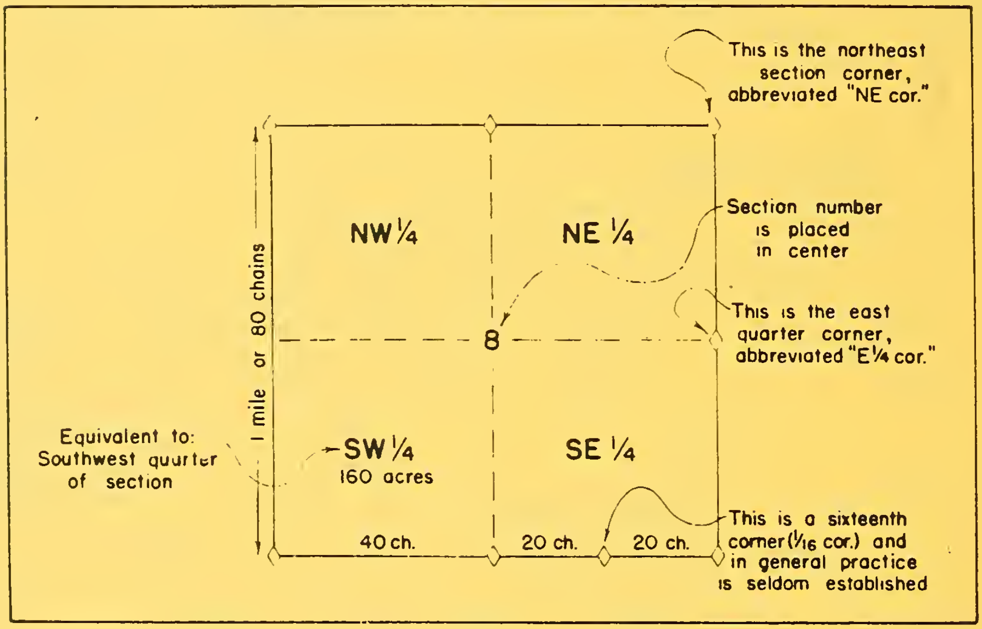


Figure 1.--Subdivision of section into quarter sections.

The quarter section may be subdivided further as shown in figure 2.

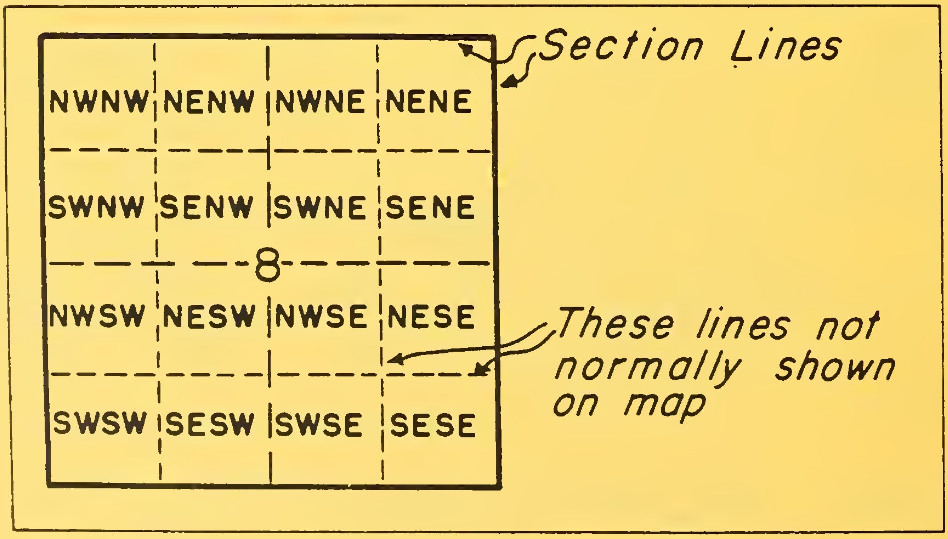


Figure 2.--Subdivision of quarter sections.

Figure 2.--Location poster for indicating section corners.

This is an example of one type of poster usually placed at section corners.

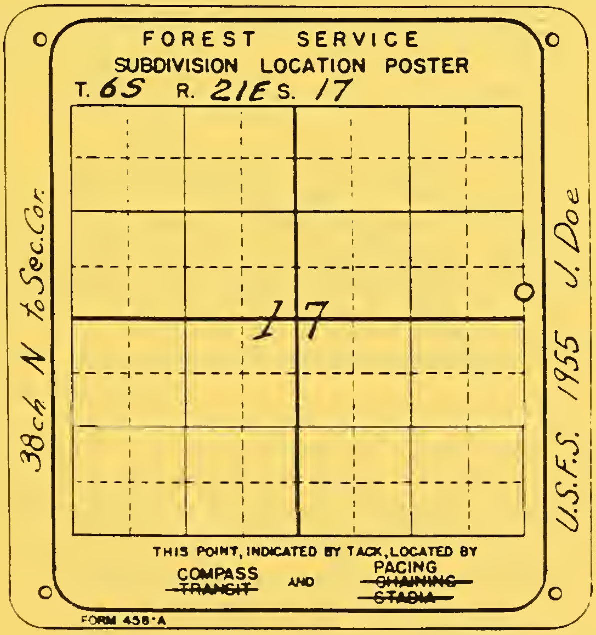


Figure 3.--Location poster for indicating section lines.

This is an example of a type of poster used at a road or trail crossing of a section line, or at a quarter section corner.

32.3 - Location Posters. Location posters, sometimes called section corner markers, section line markers, or cruiser tags, see figures 2 and 3, are used by State and Federal agencies, lumber companies, and private landowners to indicate the location of section corners and points where roads or trails cross section lines. These metal posters are 4-1/2 inches or 5 inches in size with black lines on a yellow background. In recent years, unpainted aluminum tags with the lines and lettering stamped on them, have been used. The township, range, and section are marked on the poster. A tack driven at the appropriate place on the poster shows where the poster is located according to the public land survey. Usually, the distance to a section corner is marked on the poster. On the map in figure 1, points B and C would probably be identified in the field by location posters similar to figure 2, and point A by a location poster similar to figure 3.

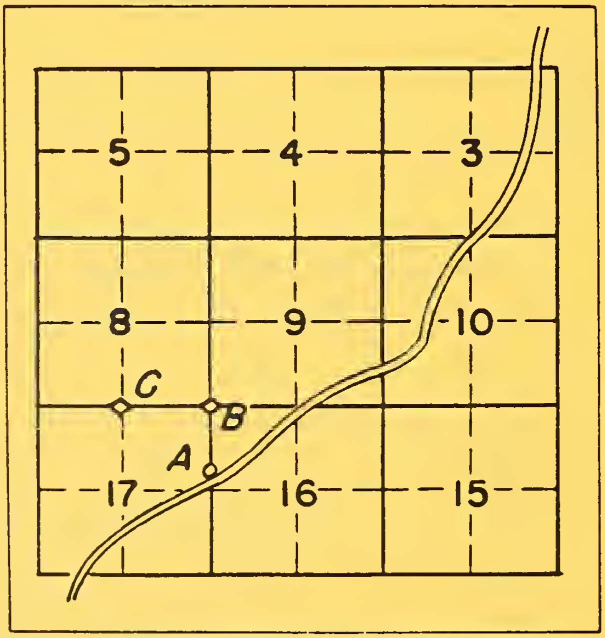


Figure 1.--Portion of a map showing typical points where location posters are commonly placed.

A. Where roads cross section line.

B. At section corners.

C. At quarter section corners.

32.4 - Topographic Maps. A topographic map is very useful to firefighters in locating fires and in locating control lines on fires. The topographic contour map commonly used in fire control work shows special features such as elevation, grades, and shape or contour of land with its ridges, peaks, and drainages. These are shown by means of contour lines. Each contour line represents a constant elevation on the ground surface. These lines may appear as more or less parallel or concentric (figure 1). All points on the same contour are the same elevation. Other features shown include survey lines (section and townships), roads, trails, streams, lakes, and cities.

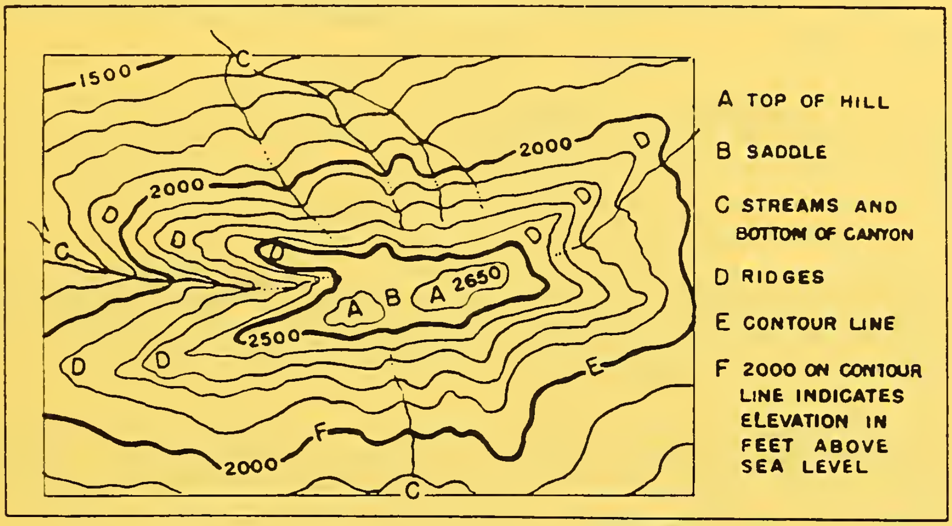


Figure 1.--Sample of topographic (contour) map.

The steepness of the topography is shown by the contour interval, or difference in elevation between the contour lines. The elevation of certain contour lines is marked on all contour maps.

To use a topographic map you will need to become familiar with the following terms and features:

1. A contour line is an imaginary line representing a constant elevation on the ground surface.

2. Contour interval is the vertical distance or difference in elevation between contours.

3. Widely separated contour lines indicate gentle slopes.

4. Close contour lines indicate steep slopes.

5. Merging contour lines indicate very steep slopes, banks or cliffs.

6. Contour lines point downhill on ridge tops. Sharp contour points indicate pointed ridges and rounded contour points indicate wider or broader ridges.

7. Contour lines point uphill or upstream where they cross drainages, and a sharp narrow "V" indicates a narrow canyon or ravine. A rounded contour line indicates a flatter or wider drainage.

8. Approximate elevations can be figured for any point on a contour map.

32.5 - Latitude and Longitude. Many forest maps include rectangular blocks with sides parallel to longitude and latitude lines. These lines with map scales aid in comparing various scale maps. Location should be recorded by latitude and longitude for later use in completing the individual fire report. Enter the latitude and longitude at the point of origin. Report degrees in whole numbers and minutes to the nearest tenth. In many cases aircraft have navigation equipment to respond by latitude and longitude. Following is a description of latitude and longitude:

Latitude. Is measured in degrees, (0 through 90), north and south of the equator. Lines of latitude are parallel; therefore, the distance between two lines of latitude remains constant, figure 1, [1° of latitude = 60 nautical miles (NM)]. One NM = 6075 feet, or 1.15 statute mile.

Longitude. Is measured in degrees (0 through 180), east and west of the "prime meridian" which runs between the north and south poles, through Greenwich, England (figure 1). (When you invent the system of latitude and longitude, as the British did, you get to decide where the lines are.) Lines of longitude are not parallel; the closer to the poles, the smaller the distance between them.

When specifying a position, longitude is normally given first. For instance, Boise, Idaho, would be located as: 43° 35' north latitude, 116° 15' west longitude.

This will locate you within approximately 1 NM (1 minute of latitude is equal to 1 nautical mile). By extending the reading to .01 minute, the accuracy is down to approximately 60 feet (.01 minute of latitude = 60.75 feet).

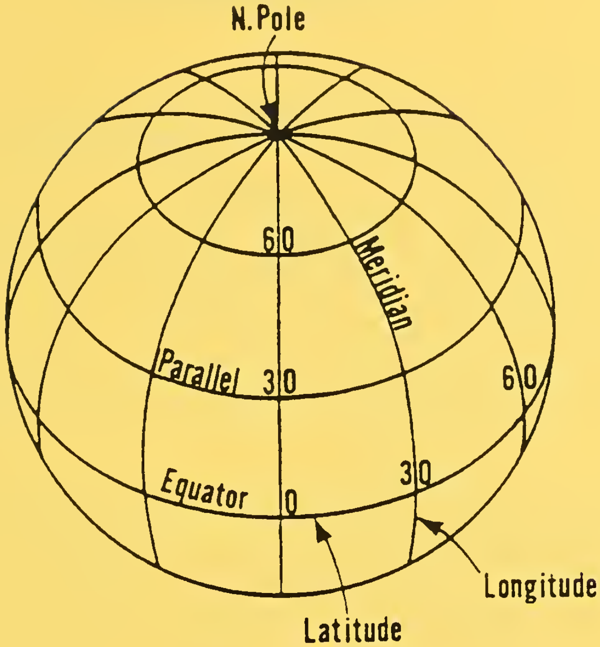


Figure 1.--Latitude and Longitude.

32.6 - Other Location Methods. In some areas the land survey system may not include township and section division. Special land surveys often follow natural geographic features as ridge tops, stream bottoms, or similar features. This system is the metes-and-bounds survey. In actual use, local people may describe a location by naming the drainage, identifying local landmarks and including the compass direction and distance from a known point to the fire or location being described. Fire towers or road junctions are frequently used as checkpoints in directing pilots to specific fires.

33 - LOCATING FIRES. Fires, particularly lightning fires, often start in remote areas, away from roads or trails. These fires are difficult to find, especially if they are small or cannot be seen from the road. There are several methods used to reach the hard-to-find fires.

33.1 - Use of Compass. To find a fire a firefighter must know the direction and distance to fire.

The direction to a fire which is away from a road is usually determined by a compass. Distance which must be covered on foot is generally measured by pacing.

The azimuth compass is best to determine directions in fire-control work. An azimuth compass is graduated with a full circle of 360 degrees (360°) called an azimuth circle (figure 1). Numbering begins with zero (0°) which is north, and proceeds clockwise.

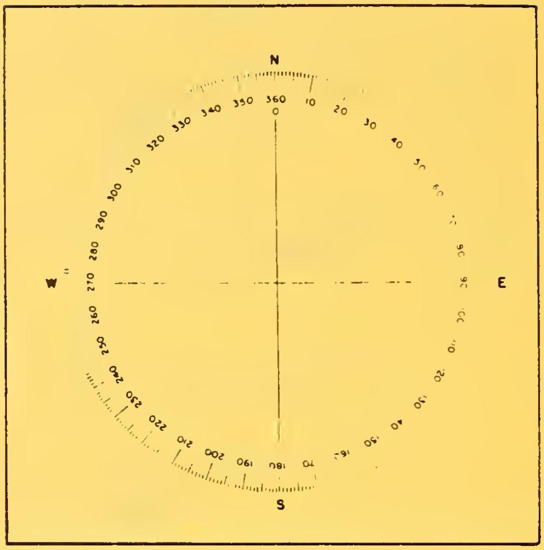


Figure 1. --Azimuth circle.

Ninety degrees is east, 180° is south, 270° is west, and 360°, the same as zero, is north. This circle is used to measure azimuth--the angle measured clockwise between any line and true north (figure 2).

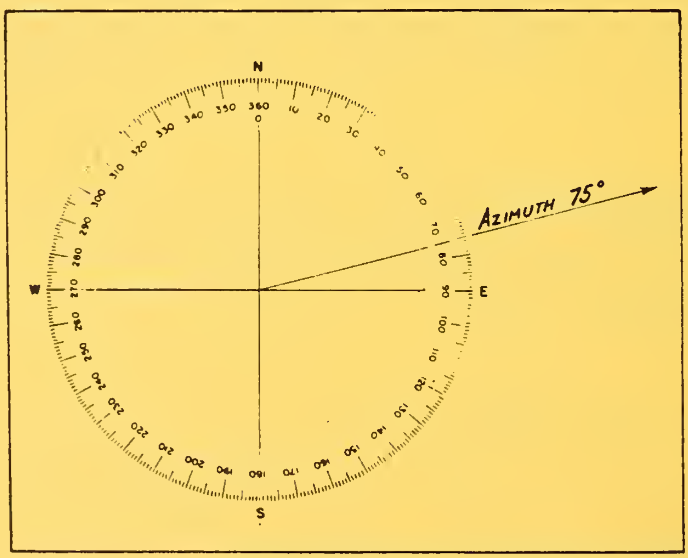


Figure 2. --Azimuth (or azimuth angle).

Two types of compasses are in general use in field work, the box compass and the silva compass.

<u>33.11</u> - <u>Box Compass</u>. The essential parts and their functions are: A magnetic needle that points to magnetic north and from which true north is determined; a graduated circle for laying off angles from true north; and a sighting line for prolonging a line of sight while following a course of direction. The counterbalance (a coil of fine wire) on the south end of the needle compensates for the pull of the earth's magnetism on the north end of the needle. The north end of the needle is marked with a small arrow.

Note: The graduated circle, (azimuth circle) on the box compass is marked counterclockwise, in order that the direction of the line of sight (azimuth) is indicated on the azimuth circle by the north end of the needle. For example (figure 1), when the sighting line is pointed toward the east, the north end of the needle points to 90°, or east.

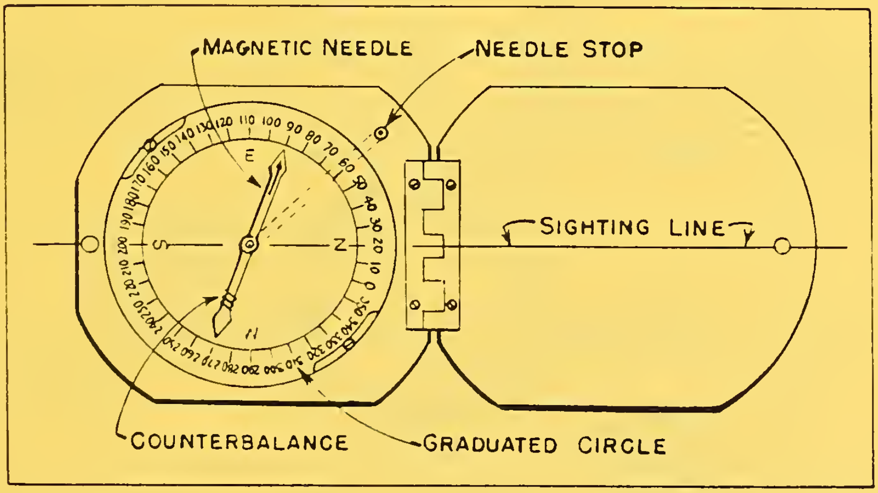


Figure 1.--Box compass.

1. <u>Magnetic Declination</u>. Directions in fire-control work always refer to true north, but the compass needle always points toward magnetic north. The difference between true north and the magnetic north is called magnetic declination, or simply the declination.

2. <u>Adjusting Box Compass for Magnetic Declination</u>. The graduated circle (azimuth circle) is adjusted on the compass to compensate for the declination so the sighting line will point to

true north when the north end of the needle points to "0" or north on graduated circle. This adjustment has already been made on the diagram of the box compass (figure 2). The declination within a work area varies so little that it is considered to be constant. Once the proper declination is set on the compass, it need not be changed when used in one area.

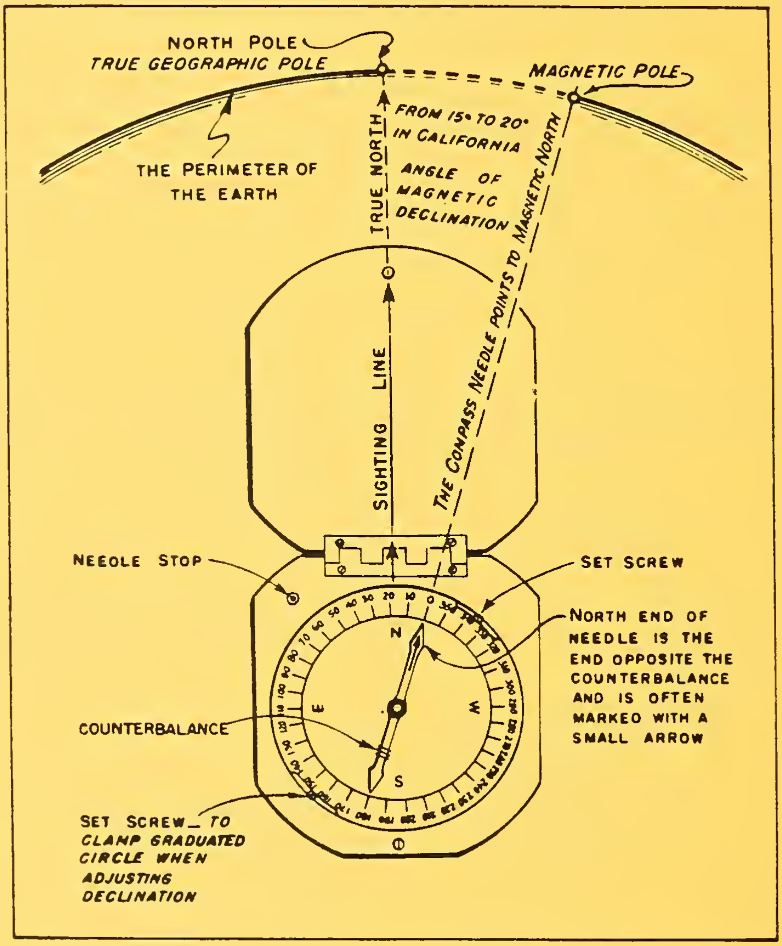


Figure 2.--Magnetic declination and the compass.

3. <u>How to Use Box Compass</u>. The proper way to stand while using the compass is illustrated in figures 3 and 4.

Figure 3.--Holding the compass.

Hold the compass in both hands, keep elbows firmly against sides, and distribute weight evenly on both feet.

Figure 4.--Prolonging the line of sight.

Look along the sighting line then raise eyes to prolong the line of sight ahead. Do not move head; raise eyes.

Steps to Follow in Using Compass.

Stand over the starting point and face in the direction that the line of sight is expected to take. For example, if the course of the line being followed is due south, face as nearly south as possible before opening the compass and freeing the needle.

Hold the compass in both hands with the left thumb over the needle stop and the elbows held firmly against the sides of the body.

Always hold the compass level.

Throughout the entire reading and sighting operation the compass should remain motionless.

To bring the north end of the needle to the desired position on the graduated circle the entire body should be swung around slowly and the feet should be moved, if necessary, to keep the body facing the line of sight. Stand with the weight evenly distributed on both feet.

Use the needle stop to lessen any excessive swinging of the needle.

When the north end of the needle has come to reset at the correct position on the graduated circle, look along the sighting line and then, by raising the eyes, prolong the line of sight.

Take note of one or more objects, such as a tree or a rock, along the line of sight.

Close the compass while it is set in this position and put it away. This prevents injury to the needle and pivot and saves time when the next sight is taken. The needle will be pointing to the bearing of the line.

Walk to the most distant object noted along the line of sight and take another sight with the compass.

Warning: Belt buckles, mechanical pencils, wire fences, and other objects containing iron or steel, will influence the position of the needle. If allowed too near the compass, while taking a sight, they may defect the needle, thus causing an error.

33.12 - Liquid-Filled Compasses. These compasses (figure 1) are simpler to operate than the box compass. The main difference between the box compass and the liquid-filled compass is that the azimuth circle on the liquid-filled compass is graduated in a clockwise direction beginning with 0° at the north. In using these compasses, disregard the azimuth circle on the plastic base. Use the azimuth graduations on the aluminum dial.

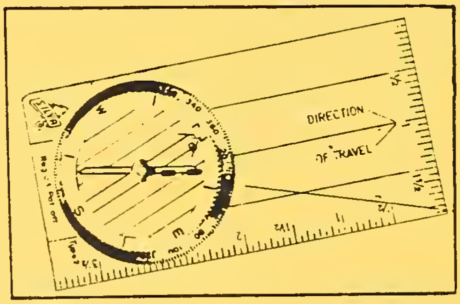


Figure 1.--Liquid-Filled Compasses.

1. Adjusting Liquid-Filled Compass for Magnetic Declination. The north end of the needle is painted red, and points to magnetic north rather than true north, the same as in the box compass.

Set the 360° (or 0°) azimuth on the "direction of travel" arrow, C, or on index pointer, depending upon model.

Opposite the correct declination for the area scratch in line A into the plastic base as shown in photograph (figure 1). This is called the "azimuth line," A.

Ink the scratch line, "azimuth line," with black or red india ink to make it stand out.

Once the proper declination has been set off on the compass it need not be changed while the compass is used in the same area.

2. How to Use Liquid-Filled Compass. Set the desired azimuth (on aluminum dial) on the "azimuth line," A.

Hold the compass in the usual manner with the "direction of travel" arrow, C, pointing directly ahead.

Turn the body (and the compass) until magnetic needle is centered in the "etched needle box," B, inside the compass housing.

Follow the "direction of travel" arrow, C. This is the desired course or azimuth.

3. How to Use Liquid-Filled Compass with Reflecting Mirror Cover. Set the desired azimuth (on aluminum dial) on the "azimuth line," A.

Hold the compass horizontally on a level with the sighting eye and adjust the cover so the reflected image of the compass housing fills the mirror (figures 2 and 3).

Move the sighting eye sideways in relation to the compass until the sighting line intersects the reflecting image of the center point (figure 2).

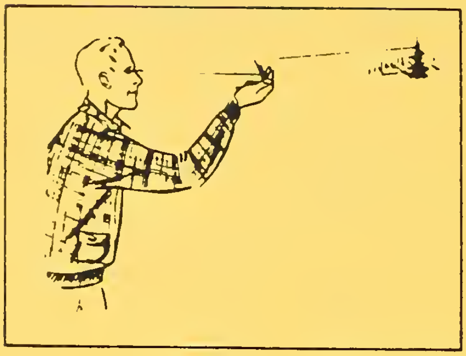


Figure 2.--Aligning sighting line with center point of compass.

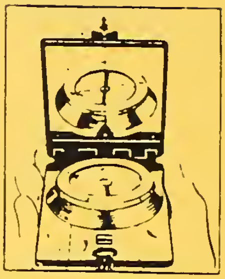


Figure 3.--Sighting with the compass.

Without changing the relationship between compass and eye, turn until the north (red) end of the compass needle points to the azimuth line (declination line) on the compass base, and the needle is centered in the etched needle box inside the compass housing.

The direction of travel (or objective in the field) will now lie straight beyond the sight on the upper edge of the cover.

When sighting uphill or downhill, lower or raise the sighting eye in relation to the compass. The transparent plate must always be kept horizontal so that the compass needle can turn freely.

33.13 - Cautions in Using Compass. Be sure that the correct declination is set off on the compass.

When running lines always follow the line of sight and not the direction of the needle.

The compass is a delicate instrument; handle it carefully.

Always follow the line indicated by the compass rather than relying on judgment as to the direction.

Remember the tree, rock, or other object sighted on your line of sight. When in doubt, take another compass reading.

Keep articles containing steel or iron sufficiently far away from the needle to avoid influencing it.

Do not attempt to repair the compass except in emergencies. Take it to your supervisor for attention.

<u>33.14</u> - <u>Back Azimuth or Backsight</u>. While following a line of sight or an azimuth one may sometime lose the landmark (tree or rock) and find it necessary to recheck the location to determine the correct line of sight or azimuth. To do this, sight back toward the starting point and then check by compass. This requires sighting a back azimuth which is in the opposite direction from the azimuth. Since there are 360 degrees in the azimuth circle, the opposite direction would be half of 360°, or 180°, difference from the azimuth. A back azimuth is calculated by adding 180° to the azimuth when the azimuth is less the 180°, or by subtracting 180° from the azimuth if it is more than 180°.

Example: See figure 1.

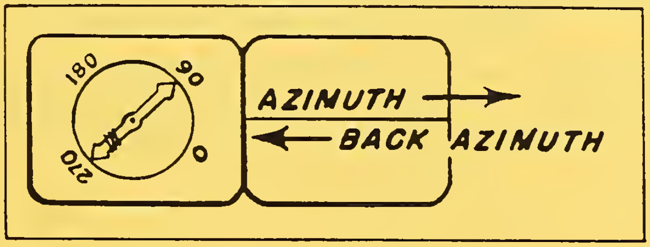


Figure 1.

The north end of the needle indicates the azimuth, which in this case is 90°, or east. The back azimuth is in the opposite direction, or it would be 90° plus 180° which is 270°, or west.

Using a back azimuth to check a line of sight or to sight back on a starting point or lookout point is called backsighting.

<u>33.15</u> - <u>Getting on Line</u>. It is not always possible to keep the lookout point or the starting point in view when traveling to a fire. When a point is reached where the lookout, or starting point, can be seen and it is desirable to get on the line between the lookout point and the fire, proceed as follows:

Face the general direction of the backsight.

Hold the compass as previously described.

(Box compass) Turn compass so north end of needle is on the back azimuth reading.

(Liquid-filled compass) Set back azimuth (on the aluminum dial) on the azimuth line.

(Box compass) When the needle has settled on back azimuth, sight along sighting line on compass.

(Liquid-filled compass) When the needle is centered in the etched needle box, sight along direction of travel line.

Note on which side and the approximate distance the line of sight misses the lookout point.

If lookout point is to the right of line of sight, move to the right. If lookout point is to the left of line of sight, move to the left.

Estimate the distance that the line of sight misses the lookout point. Move over this distance, either to the right or to the left, as required. Take another backsight on the lookout point. Repeat this procedure until the line of sight passes through the lookout point.

This then is the line between the lookout point and the fire. Then turn the compass to the azimuth reading and proceed along the line toward the fire (figure 1).

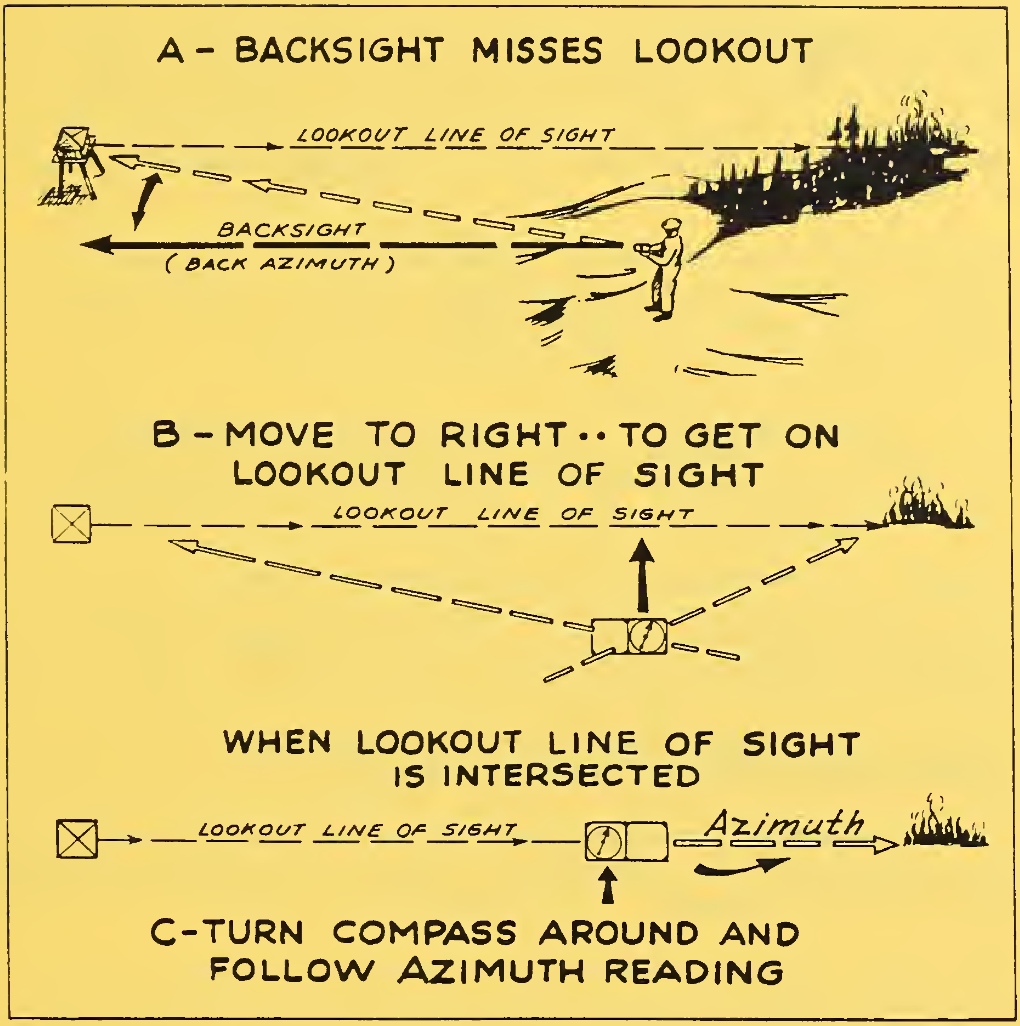


Figure 1.--Getting on lookout's line of sight.

<u>33.2</u> - <u>Pacing to Measure Distance</u>. Pacing is the measuring of horizontal distance on the earth's surface by counting steps of a known length. With practice a person can attain accuracy sufficient for most field measurements needed in fire-control work.

The chain is the land surveyor's unit of linear measure. One chain equals 66 feet and is the basic unit for measuring distances in fire-control work. There are 80 chains in 1 mile.

A pace is the distance on level ground between the heel of one foot and the heel of the same foot where it next touches the ground while walking normally; that is, two normal steps.

33.21 - Determining Pace. Because the length of pace varies with the individual, it is necessary for you to learn the length of your normal pace. In order to pace a given number of chains to a fire, you also need to know how many paces you take to a chain. To determine the length of a pace, and how many paces, use a chain in level, open country.

With a steel tape, measure a course of several chains on level ground. Mark each end with a stake. Walking normally from one stake to the other, count the paces. Divide by the number of chains in the course to get the paces per chain.

This one-chain pace-count, (paces per chain) when multiplied by the number of chains to a fire, will give the number of paces to the fire in level open country. By dividing the one-chain pace-count into 66 feet, the length of each pace can be determined.

Example: Assume the measured course is 3 chains or, 198 feet (66 x 3), and this distance is covered with 36 normal paces. Therefore, the pace is 36/3 or 12 paces per chain. Each pace is 198/36 or 5-1/2 feet long.

33.22 - Determining Distance on Sloping Ground. Steepness of slope affects pacing in two distinct ways.

First, the natural length of step in walking or climbing up or down varies with the steepness of slope, so the number of paces per chain must change.

The second effect of slope is that land surveys are based on horizontal distances, not slope distances. In order to measure a given horizontal distance; for example, 1 chain, a person must travel more than 1 chain when walking on a slope. This is equally true whether going uphill or downhill. The difference between the horizontal distance and the slope distance (figure 1) becomes increasingly pronounced as the steepness of slope increases.

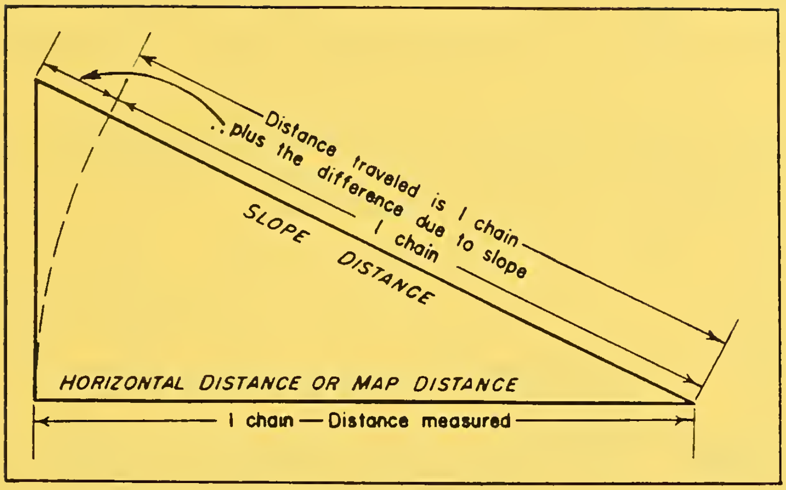


Figure 1.--Difference due to slope.

When measuring distance to a fire, a person may find several changes in slope. The distance traveled on the surface in measuring 1 mile is much greater than the horizontal distance. The allowance for slope (figure 2) or any other factor is usually made as each pace is covered so that a single pace count always indicates the horizontal distance covered. In other words, if a person uses 12 paces to cover a chain on level ground, each pace counted should equal 1/12 chain horizontal distance measured regardless of slope or any other factor.

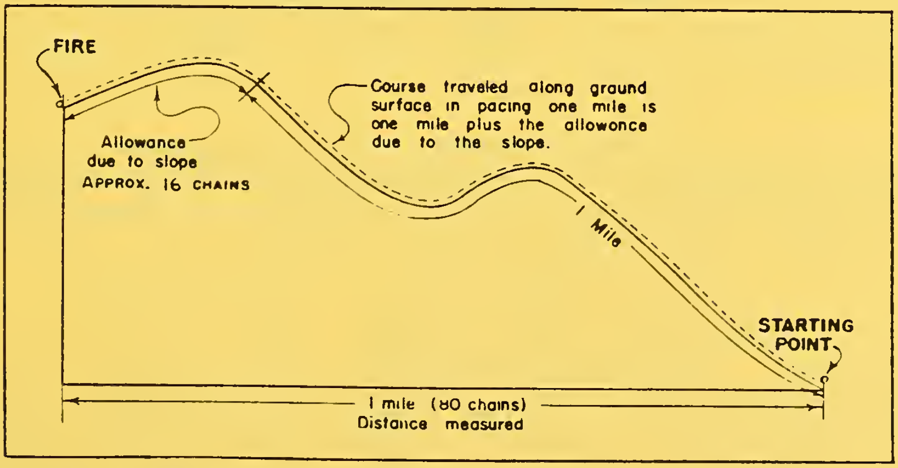


Figure 2.--Allowance needed due to slope.

The allowance for slope is applied continually as the pacing progresses. The allowance that is needed will vary with the steepness of slope. The extra steps taken to cover the additional distance traveled due to slope are not counted.

33.23 - Determine Paces per Chain on Sloping Ground. To determine how much to add because of slope, count on slopes in order to measure horizontal distances by pacing.

Lay off a 3-chain horizontal distance with a steel tape on a medium slope. This can be done by holding the tape level on each measurement and using a plumb bob on the downhill end of each measurement. Mark both ends of the course. Using normal steps, pace upward on this course the number of paces needed to cover three chains on the level. Pace the distance remaining to the end of the course. The latter is the amount which must be added to get level distance on a three-chain distance traveling uphill. Divide this figure by three to get the amount for one chain. Divide the latter figure by the paces per chain to get the amount to add to each pace.

Example:

Firefighter goes 36 paces.

Has 18 feet left to end of course.

$\frac{18 \text{ ft}}{3 \text{ ch.}}$ = 6 feet per chain (addition per chain to get level distance)

$\frac{6 \text{ ft. ch.}}{12 \text{ paces/ch.}}$ = 1/2 foot per pace (addition per pace to get level distance)

Supplemental Action.

Repeat this process on the same course going downhill. Record all figures in a notebook. Use them until such skill in pacing has been acquired as to make frequent reference no longer necessary. On steeper slopes add more slope correction, and on gentler slopes lessen the slope correction allowance.

33.24 - Other Factors Affect Pacing. Human factors must be considered. A person's vitality may decrease during a day's work, after a poor night's sleep, or with illness, and as a result, paces may shorten. A step is shorter when traveling slowly than when moving at a normal rate. Generally, you will lengthen your step in the early morning, or when in a hurry, or on gentle slopes after leaving rough country. All of these factors must be considered in pacing.

On loose, rocky, or swampy soils it is more difficult to pace than on firm soil, and allowance must be made for these conditions.

It is desirable to learn to estimate short distances; occasionally, a firefighter will encounter a stream too deep to wade or a slope too steep to cross, and the distance must be estimated. In rough country or dense brush it is more accurate to estimate a short distance to some object than it is to pace the distance. First practice estimating in units of paces, and then increase the estimate to units of chains. Verify each estimate by pacing the distance during practice. Continue practice until the desired accuracy is reached.

33.3 - Use of Radio Equipment and Signal Mirror

1. Using Signal Mirror and Portable Radio to Locate Fire. By signaling with a mirror and communicating by portable radio the firefighter's location may be determined. The lookout can then direct the firefighter as to the route of travel to the fire. This action may have to be repeated several times.

2. Alternate Action Suggestions. Any type of mirror can be used, for example, rearview or sideview automobile mirror.

If no mirror is available, or the sun is not suitably positioned for use of a mirror, a smoke signal may be used. In these cases care must be taken to put the fire out before leaving it.

At night a headlight, or other light may be used to signal the lookout.

3. Using Portable Radio and Signal Mirror to Locate Fire Spotted by Airplane. A radio-equipped reconnaissance plane and firefighter equipped with signal mirror and portable radio can work together to place the firefighter at the fire.

Firefighter establishes radio contact with the plane and by mirror flashes are located by the plane observer. The observer then directs the firefighter to the fire by radioed instructions.

33.4 - Alternate Actions. If firefighter has no mirror, or the sun is in the wrong spot, alternate methods are:

1. Make a display of conspicuous material--a white undershirt, colored markers of bright paper or cloth, or hard hats painted a highly visible color. It helps to display such signals from a tree, if possible. Signal streamers are available and used in many places.

2. Use the radio to tell the plane observer where to look. Describe location by landmarks or position relative to the plane at a given time.

3. If a firefighter is not equipped with a radio and cannot find the fire, the plane can be signaled until the plane observer determines the location. The plane can then fly directly to the fire, circle it several times, and repeat the maneuver. Or, the plane observer may drop markers when directly over the fire. It is important that the plane be visible to the firefighter when the marker is dropped.

33.41 - Suggested Aids in Finding Small Fires. When the firefighter reaches the determined location of the fire, it may be difficult to immediately find the fire. The fire may be in some obscure spot or be too small to be readily seen. The firefighter should then mark the spot or locate a landmark which can be returned to. Then one of the following aids may be helpful in finding the fire:

1. Watch for fires which may be burning in tree tops or forks of trees.

2. Smoke can generally be seen more easily when looking into the sun.

3. Smoke can usually be smelled when downwind from the fire, or even in the general area.

33.5 - Measuring Burned Areas. Area and perimeter are computed on all fires. The firefighter may sometimes be required to do this. The common units of measurement are: 1 chain = 66 feet; 10 square chains = 1 acre; 43,560 square feet = 1 acre. Long narrow fingers should be measured separately when computing total area. Area of "spot fires" should be added to the size of the main fire.

1. Determining Acreage of Small Fires. Firefighter should determine acreage of a small fire as shown in figure 1. After the fire is mopped up the general shape should be determined. This can be done by walking around and through the burn. The average dimensions can be obtained by pacing. This information is recorded in the firefighter's notebook. Also, a sketch of the shape of the fire should be made. See figure 1.

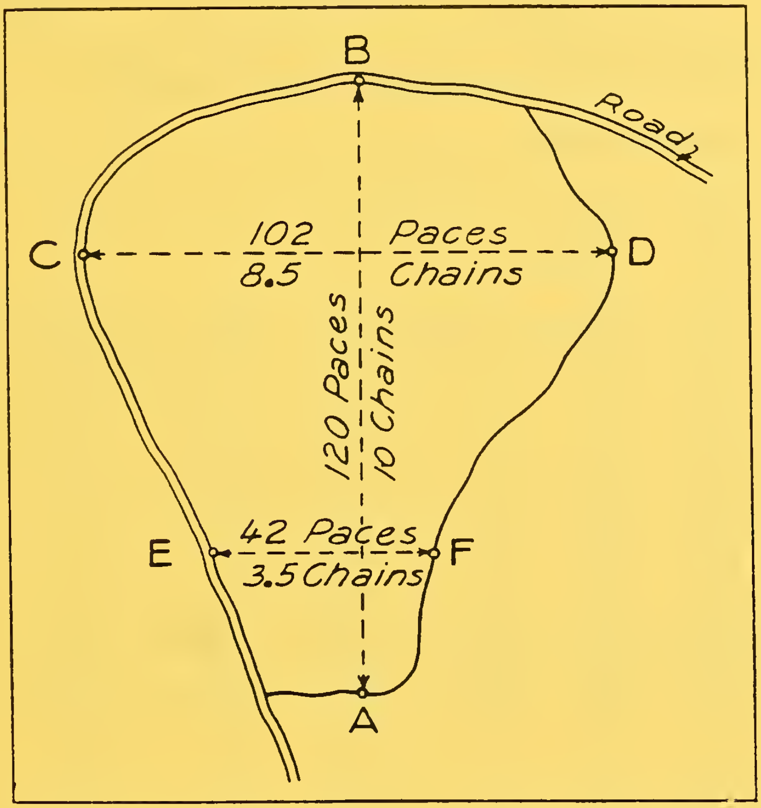


Figure 1.--Measuring burned area.

Since the length of the fire is about the same any way it might be measured, the length along the line A-B is paced, and the number of paces recorded in the sketch. The paces may be converted to chains. Similarly, the lines C-D, and E-F are paced, recorded, and converted. In the sketch, C-D is the widest part of the fire, and E-F the narrowest part. With this information the area of the fire can be determined by the following steps.

a. The average width equals the sum of the two measurements divided by 2.

3.5 chains = width of fire at E-F.

8.5 chains = width of fire at C-D.

12 chains = sum.

12 ÷ 2 = 6 chains, average width.

b. The area in square chains equals the average width times length.

6 chains = average width from step (a) above.

10 chains = length

6 x 10 = 60 square chains.

60 ÷ 10 = 6 acres.

c. The following tables gives radius lengths from small fires of sizes most frequently handled by smokechasers.

A circle with a radius of 37 feet covers 1/10 acre.

A circle with a radius of 53 feet covers 2/10 acre.

A circle with a radius of 59 feet covers 1/4 acre.

A circle with a radius of 64 feet covers 3/10 acre.

A circle with a radius of 83 feet covers 1/2 acre.

FIREFIGHTERS GUIDE

AREA-PERIMETER TABLE

Perimeter of fire corresponding with area enclosed by it

Perimeter is shown in chains.

Area in acres	Minimum 1/ perimeter 1 C	Probable 2/ perimeter 1.5 C	Maximum 3/ perimeter 2 C	Area in acres	Minimum perimeter 1 C	Probable perimeter 1.5 C	Maximum perimeter 2 C
.10	3.5	5.25	7.00	21	51.4	77.10	102.80
.20	5.0	7.50	10.00	22	52.5	78.75	105.00
.30	6.1	9.15	12.20	23	53.7	80.55	107.40
.40	7.1	10.65	14.20	24	54.8	82.20	109.60
.50	8.0	12.00	16.00	25	56.0	84.00	112.00
.60	8.7	13.05	17.40	26	57.1	85.65	114.20
.70	9.4	14.10	18.80	27	58.3	87.45	116.60
.80	10.0	15.00	20.00	28	59.4	89.10	118.80
.90	10.6	15.90	21.20	29	60.4	90.60	120.80
1.00	11.2	16.80	22.40	30	61.5	92.25	123.00
1.10	11.7	17.55	23.40	32	63.4	95.10	126.80
1.20	12.3	18.45	24.60	34	65.4	98.10	130.80
1.30	12.8	19.20	25.60	36	67.2	100.80	134.40
1.40	13.2	19.80	26.40	38	69.1	103.65	138.20
1.50	13.7	20.55	27.40	40	70.9	106.35	141.80
1.60	14.2	21.30	28.40	42	73.1	109.65	146.20
1.70	14.6	21.90	29.20	45	75.2	112.80	150.40
1.80	15.1	22.65	30.20	47	77.2	115.80	154.40
1.90	15.5	23.25	31.00	50	79.3	118.95	158.60
2.00	15.9	23.85	31.80	55	83.2	124.80	166.40
2.25	16.8	25.20	33.60	60	86.8	130.20	173.60
2.50	17.7	26.55	35.40	65	90.4	135.60	180.80
2.75	18.6	27.90	37.20	70	93.7	140.55	187.40
3.00	19.4	29.10	38.80	75	97.0	145.50	194.00
3.25	20.3	30.45	40.60	80	100.2	150.30	200.40
3.50	21.0	31.50	42.00	85	103.4	155.10	206.80
3.75	21.7	32.55	43.40	90	106.3	159.45	212.60
4.00	22.4	33.60	44.80	95	109.3	163.95	218.60
4.25	23.2	34.80	46.40	100	112.1	168.15	224.20
4.50	23.7	35.55	47.40	105	114.8	172.20	229.60
4.75	24.5	36.75	49.00	110	117.5	176.25	235.00
5.00	25.0	37.50	50.00	115	120.2	180.30	240.40
5.25	25.8	38.70	51.60	120	122.8	184.20	245.60
5.50	26.3	39.45	52.60	125	125.4	188.10	250.80
5.75	26.8	40.20	53.60	130	127.8	191.70	255.60
6.00	27.5	41.25	55.00	135	130.3	195.45	260.60
6.50	28.6	42.90	57.20	140	132.6	198.90	265.20
7.00	29.7	44.55	59.40	145	134.9	202.35	269.80
7.50	30.7	46.05	61.40	150	137.3	205.95	274.60
8.00	31.7	47.55	63.40	155	139.6	209.40	279.20
8.50	32.6	48.90	65.20	160	141.8	212.70	283.60
9.00	33.6	50.40	67.20	165	144.0	216.00	288.00
9.50	34.6	51.90	69.20	170	146.1	219.15	292.20
10.00	35.5	53.25	71.00	175	148.3	222.45	296.60
11.00	37.2	55.80	74.40	180	150.4	225.60	300.80
12.00	38.7	58.05	77.40	185	152.5	228.75	305.00
13.00	40.4	60.60	80.80	190	154.6	231.90	309.20
14.00	41.9	62.85	83.80	195	156.5	234.75	313.00
15.00	43.3	64.95	86.60	200	158.6	237.90	317.20
16.00	44.8	67.20	89.60	205	160.5	240.75	321.00
17.00	46.2	69.30	92.40	210	162.5	243.75	325.00
18.00	47.5	71.25	95.00	215	164.4	246.60	328.80
19.00	48.8	73.20	97.60	220	166.3	249.45	332.60
20.00	50.2	75.30	100.40				

1/ Minimum perimeter is that of a circle corresponding with the area.

2/ Probable perimeter is 1.5 times that of a circle corresponding with the area.

3/ Maximum perimeter is 2.0 times that of a circle corresponding with the area.

Figure 2.

CHART FOR USE WITH MIL-SCALE IN DETERMINING FIRE DIAMETERS

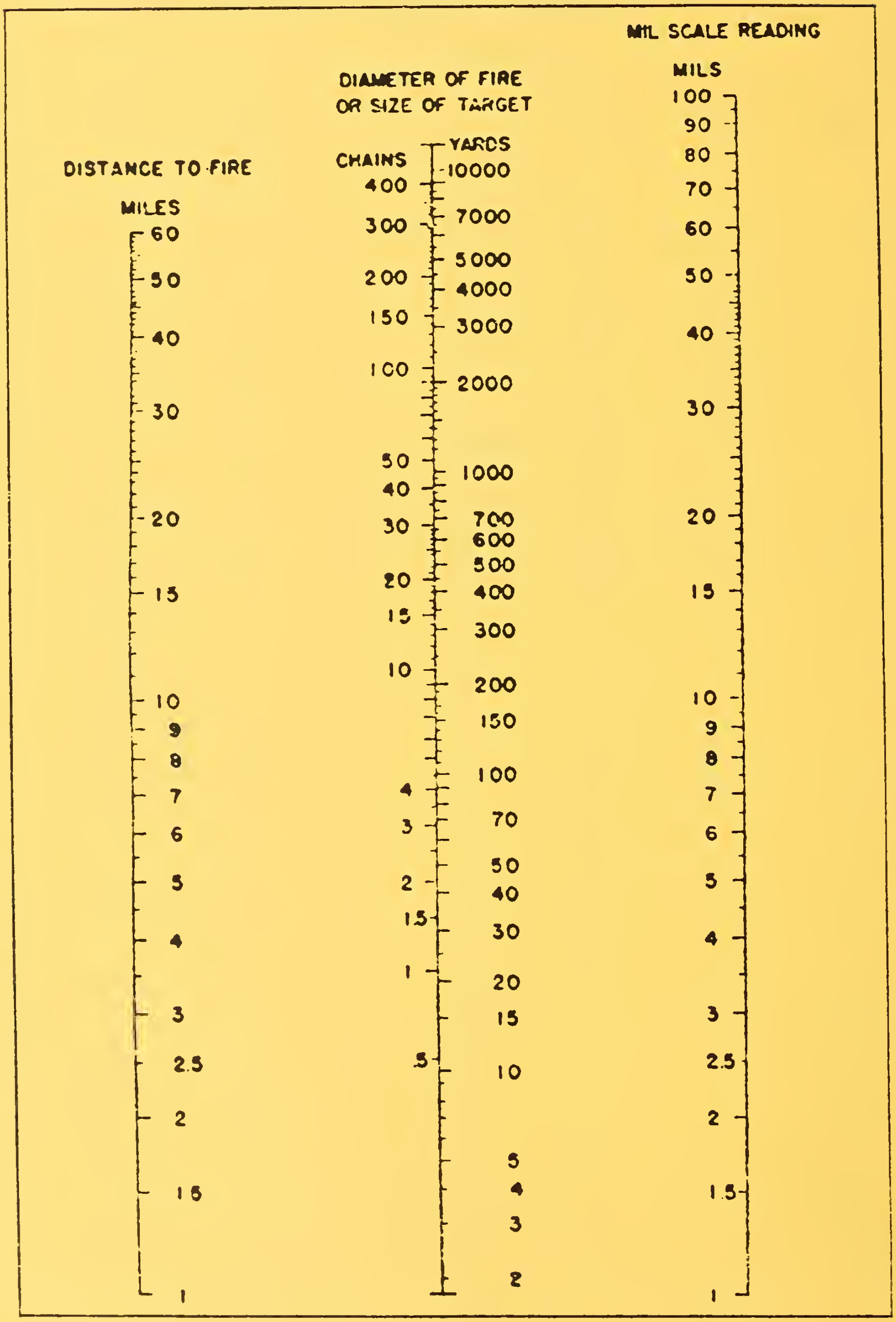


Figure 3.

34 - DETECTION. Detection is the work or act of discovering and reporting fires. Discovering a fire or smoke and reporting it accurately is necessary before suppression work can begin. There are two systems of detection: ground and aerial.

34.1 - Ground Detection. Ground detection is concerned with all detection that does not use aircraft.

34.11 - Lookout Duties

1. Introduction. Fire detection lookouts are the ground eyes of the protection organization. Seeing a fire or smoke and reporting rapidly and accurately what is seen is essential to get early work on a fire.

This chapter includes specific qualifications and duties of a lookout. General items which also concern lookouts are covered in other chapters.

Some of these items are safety, public contacts, and communications. A lookout who also serves as a firefighter should also refer to Chapter 50 - Fire Suppression.

34.11a - Qualifications of Personnel. To do a good job, the lookout must have special qualities: good health, good eyesight, interest in the job, ability to live in isolated locations for long periods of time, read maps, use firefinder, use radio and other tools, and to think clearly and coolly in an emergency.

34.11b - Learning the Country. It is essential that a lookout know the location and names of the topographic features of the country which can be seen. Refer to local landmarks repeatedly to check locations of smokes. Some of these landmarks are peaks, streams, roads, buildings--any feature which may be used to describe a location.

A lookout should acquire a basic knowledge of location landmarks as quickly as possible. Study the country until confident that you know its features. Be able to locate accurately on the map and describe, by local name, landmarks of any point in the seen area.

1. How to Systematically Learn Country Seen from Lookout

a. Pick out prominent landmarks, peaks, streams, and buildings.

b. Learn their names from map or by asking questions. Your Fire Management Officer (FMO) or dispatcher will assist.

c. Use firefinder to locate them on map.

d. Identify other landmarks by referring to these known points.

e. Observe car dust to locate road locations.

f. The smokes from sawmills, industrial plants, and residences may show their locations.

g. Mirror flashes from field personnel can give definite locations on the ground. Arrange with the dispatcher for help of this kind. Description of location will be given by radio or telephone.

h. Travel through as many different parts of the territory as possible to and from the lookout. Look back toward the lookout frequently; this will help get the lay of the land.

2. <u>How to Identify Landmark by Use of Firefinder</u>

a. Set firefinder sights on the landmark.

b. Study topography along line of sight. (The tape crosses the same objects on the map as appear along the line of sight.)

c. Working from known topographic features, the location of the landmark can be determined as well as on the map, even if the name is not given or known.

<u>34.11c - Record of Landmark Locations</u>. Each lookout should keep a record of four kinds of landmarks.

1. <u>Orientation Points</u>. An orientation point is a landmark used to orient the firefinder and to check its adjustments. The azimuth of an orientation point is posted in each station.

2. <u>Legitimate Smokes</u>. Permanent and periodic smokes such as sawmills, refuse dumps, residences, campgrounds, railroads, logging operations, and industrial operations.

3. <u>False Smokes</u>. Any phenomenon likely to be mistaken for smoke, such as gray cliffs, dust from a livestock driveway, road dust, or fog.

4. Key Points. Any location which helps one know the country and may be useful in describing others locations. These may be peaks, saddles, ridges, canyons; streams, lakes, waterfalls, dams; points on roads or trails; or locations of heavy human use or high hazard.

Several systems have been developed to record these landmarks. The FMO will suggest which one to use. A sample, figure 1, follows at the end of this code.

a. Use of Form, Orientation Point, Legitimate Smokes, False Smokes, and Key Points. The columns for this form will be filled in as follows: Place Name: Give the name of the orientation point (for example, Pinnacle Point), legitimate smoke (for example, Burton Mill), false smoke (for example, Salmon Highway Construction) or key point (for example, Payne's Peak).

The azimuth and vertical angles are recorded in the second and third columns.

b. Smoke Base or Point Visible from Lookout. Record "Yes" or "No." The smoke from some legitimate source, such as a mill, may not be seen until it rises above a ridge, or the glow of the lights of a town may be visible at night although the lights cannot be seen directly.

c. Elevation. Record the approximate elevation of the point of smoke.

d. Remarks. State whether the point listed is a key point, legitimate smoke, or orientation point, and give a brief description or pertinent information regarding the point.

Two general systems are used to record an orientation point, key points, false smokes and legitimate smokes: one is to record them in sequence just as they are seen as the firefinder is turned from azimuth 0 to 360 degrees; the other is to group them separately--first the orientation points, then legitimate smokes, false smokes, and key points.

ORIENTATION POINT
LEGITIMATE SMOKES, FALSE SMOKES,
AND KEY POINTS

LOOKOUT STATION High Mountain OBSERVER Hugh L. Lowe DATE June 3, 1985

Place name	Azimuth reading	Vertical angle	Smoke base or point visible from lookout?	Elevation	Remarks: Significant description or information. State whether orientation point, legitimate smoke, *-false smoke, -* or key point.
Burat Peak	15° 45'	-3° 30'	yes	6,245	Orientation Point
Sunset Point	271° 15'	-4° 30'	yes	5,892	Alternate orientation point
White Pine Sawmill	2° 30'	-6°	yes	4,300	Legitimate smoke
Butteville Rubbish Dump	9° 00'	-6°	yes	4,340	" "
					" Mill closed down 7/15
Indian Trap Sawmill	165° 30'	-5° 30'	No	4,250	" Smoke rises beyond Squaw Ridge
King Solomon Mill	345° 45'	2° 30'	yes	4,800	" occasional dust - looks like smoke
Western Lumber Co. Plant	250° 00'	-4° 30'	yes	4,050	" Fire about Aug 3: Lumber resurfacing Mill & Plant
Boonville Dump	315° 00'	-1° 30'	No	4,600	" Smoke rises thru Cedar Pass
Granite Knob	5° 30'	+1° 30'	yes	7,608	Key Point
Butteville	8° 30'	-6°	yes	4,340	Key Point (lights visible at night)
Manzanita Lookout	51° 15'	+30'	yes	7,245	Key Point
Indian Creek Dam	183° 30'	-5° 30'	yes	4,250	Key Point
Taylorville	187° 30'	-5° 30'	No	4,250	Key Point - glow from lights visible at night
Lucia Saddle	220°	-30'	yes	6,800	" Summit of Indian Creek Highway

Figure 1.

34.11d - Locating and Identifying Smokes

1. Looking for Smoke. Observations for smoke can be best obtained from a combination of general and intensive methods.

General observations are an extensive survey of the entire country instead of an intensive look at any particular point. Knowledge of the country will enable a lookout to pick out instantly anything unusual.

General observations are made continuously during daylight hours in the following manner: make a systematic slow scanning of the entire seen area (figure 1); do not actually look on any particular point unless attracted by something unusual. Spend more time in scanning areas of high risks such as logging operations, camping areas, fishing streams, and well traveled roads, but do not overlook or skip areas of low risk or little use. After a lightning storm, thoroughly scan areas that received strikes.

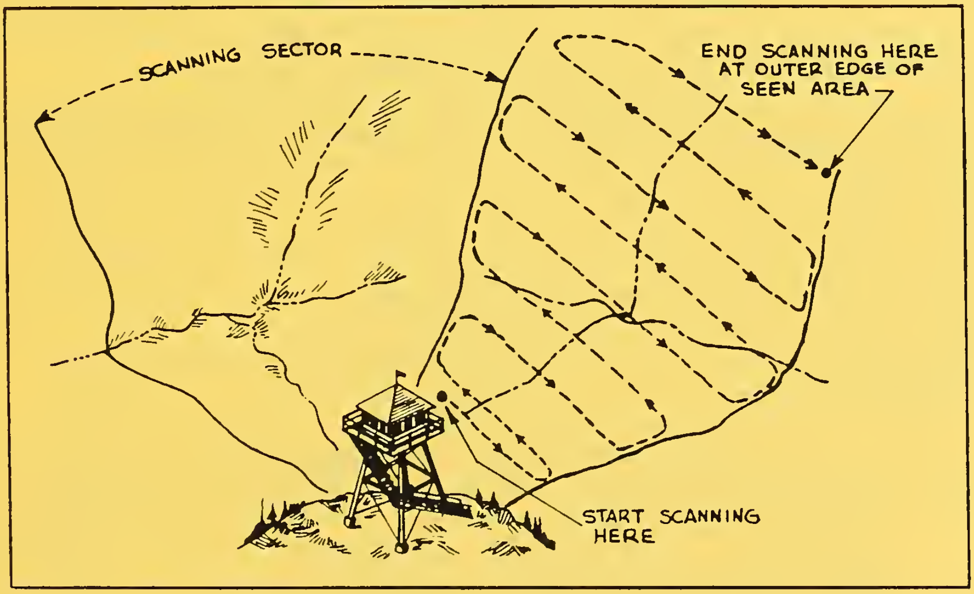


Figure 1.--Systematic method of searching for smoke.

Make intensive observations at 15-minute intervals during daylight hours in the following manner: divide the entire seen area into units or sectors with readily recognized boundaries. Use ridges and drainages as boundary markers or use the firefinder to form sectors of about 45 degrees (45°) each. These sectors must be small enough to allow thorough examination with little shifting of the eye. Start the intensive search in the same place each time

and progress in a clockwise direction until all units have been examined. In each sector start by examining the country nearest, and progress outward to the limits of the seen area; make an intensive part-by-part examination of each sector. Focus your eyes on those particular points of high hazard, within the sector, which you have determined are areas of heavy use. Depending on size and character of seen area, an intensive check can be made effectively in 4 to 6 minutes.

Colored glasses may be used to relieve eyestrain.

Good binoculars are an essential tool in making your observations. They will help identify small or difficult smokes, false smokes, and legitimate smokes. Excessive use of binoculars may result in eyestrain, so be careful.

Constant practice enables a lookout to make these general and intensive observations while performing housekeeping duties, checking on a going fire, or in the presence of visitors.

A lookout must check with the dispatcher before leaving the station for even short periods of time.

2. Identifying Smokes. The lookout's ability to rapidly and properly identify smokes will aid the dispatcher in deciding the action to be taken.

There are three types of smokes to deal with--legitimate smokes, false smokes, and illegitimate smokes.

Whenever there is doubt about a smoke, report it at once to the dispatcher.

a. Legitimate smokes are authorized by law or permit, and are under control. They come from sources such as locomotives, sawmills, ranches, debris-burning, industrial operations, or campfires, and should be currently recorded on form "Orientation Point, Legitimate Smokes, and Key Points." This type of smoke has a definite pattern as to time of day it appears, volume and color of smoke, and length of time visible.

Any change from this pattern should be reported to the dispatcher on the chance the legitimate fire may have escaped control.

b. False smokes are anything that might be mistaken for smoke under certain light and weather conditions. Common things reported as false smokes are distant rock slides, openings in timber or brush, small areas of dead timber, dust

from vehicles or livestock, and fog or cloud puffs. After a rain it is common for distant rising small clouds of vapor to look like smoke.

Permanently fixed false smokes, such as rock slides or dead timber, should be recorded on form "Orientation Point, Legitimate Smokes, and Key Points."

When in doubt about a possible false smoke, report it as a fire.

c. Illegitimate smokes are any smokes not authorized by law or permit, or any fires out of control.

Report all illegitimate smokes observed to the dispatcher at once.

3. Describing Smoke. The description of volume, character, and color of the smoke will be an indication to the dispatcher of size, intensity of fire, and of material burning.

a. Volume may be described in general terms as small--amount of smoke from average campfire; medium--amount of smoke from 10 campfires; and large--any smoke larger than above.

The fact that the volume is increasing or decreasing is most important.

b. Character may be described as thin--a smoke narrow in width and of light density; heavy--smoke of greater density; billowy--large volume of smoke rising vertically which may have a mushroom or thunderhead effect on top; drift--smoke that has followed air currents and gives a long strung-out effect; and blanket--layer of smoke over large area.

c. Color of smoke indicates the type of material burning, such as white smoke--generally grass, herbs; grey smoke--light brush, sage, buckwheat; black smoke--heavy brush, oak, manzanita, pitchy logs, sedgegrass; blue smoke--same as black smoke, less density; yellow smoke--generally pine trees, herbs; and coppery smoke--light brush, sage, buckwheat.

34.11e - Using Osborne Firefinder. The Osborne Firefinder is the basic tool for locating fires. The accuracy of reports of fires will depend on how well the instrument is adjusted and oriented. Knowledge of the various parts of the firefinder (figure 1) will enable the lookout to keep it in adjustment.

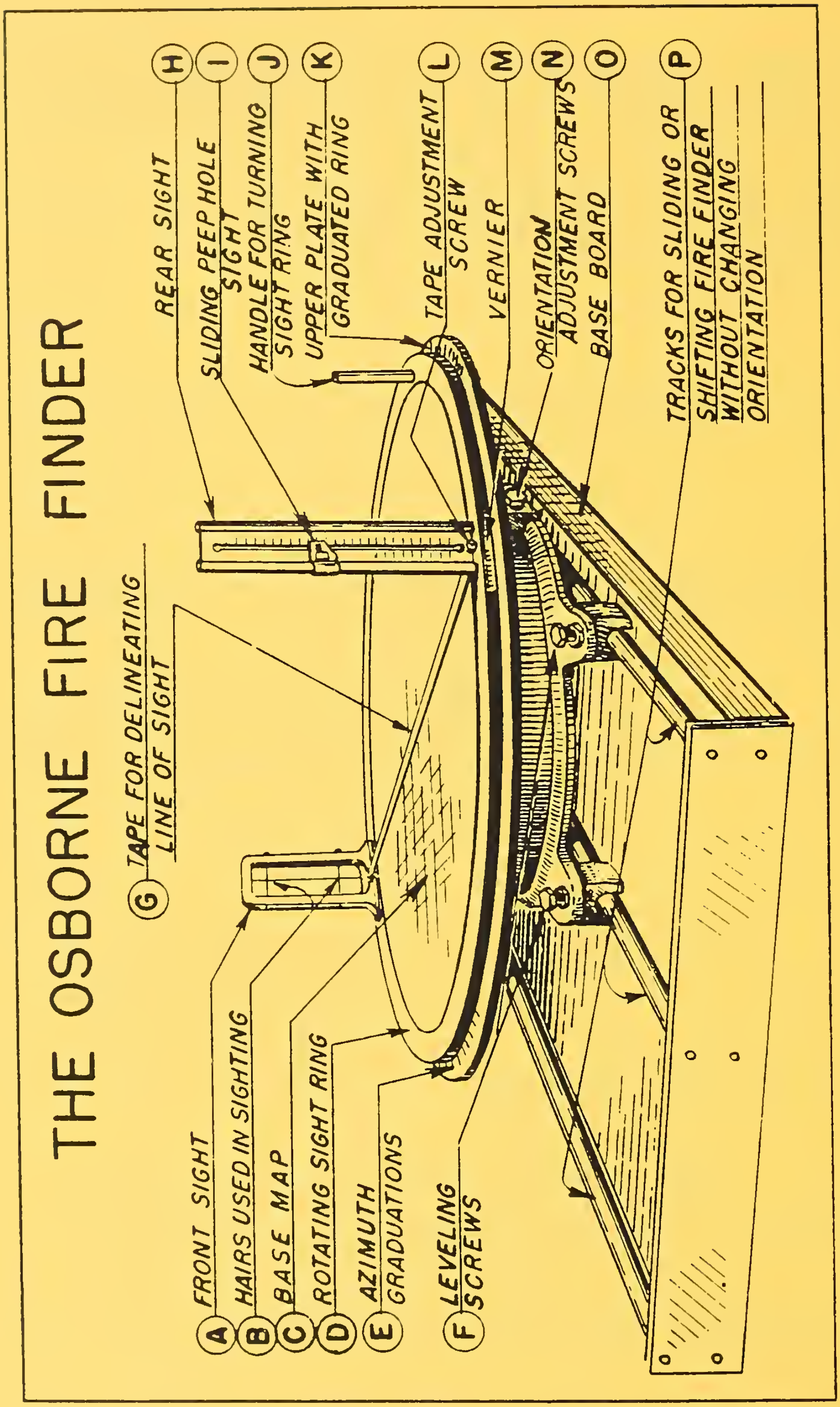


Figure 1.--The Osborne Firefinder.

FIREFIGHTERS GUIDE

1. Adjusting and Orienting Firefinder

a. Leveling Firefinder. Each morning check to see that the firefinder is level (figure 2).

Place level tube on machined surface of graduated rim at about 45 degrees (45°) azimuth.

If the bubble in the level tube is not exactly centered, turn leveling screws until it is.

Then place the level on the graduated rim at approximately 135°, next at 225°, and last at 315°. If not level, adjust leveling screws at each setting.

To prevent errors in horizontal readings, keep guide lugs on the base of the firefinder below the center line of track to prevent sideplay. The slightest sideplay will make horizontal readings incorrect.

If you have trouble leveling the finder in more than one position, contact the FMO for proper instructions.

The firefinder must be level before any further adjustments can be made.

b. Checking Sights and Vertical Hair for Plumb. Firefinder has been leveled. Check vertical hair in front sight by following steps:

Hang weighted thread or string from nail inside window frame.

If vertical hair does not coincide with string, hair is not straight.

Adjustment: Loosen screw on sight fastening the horsehair; pull the horsehair tight; tighten the screw again; hair is then tight and straight. If it does not coincide with string, notify FMO.

Replacing vertical hair: Have on hand extra supply of dark horsehair. (In emergency, black thread or fine wire may be used temporarily.) Loosen both top and bottom screws holding hair; thread new hair through bottom holes in sight standard; wrap hair around bottom screw and tighten screw; thread hair through top hole; pull tight; wrap around top screw and tighten screw.

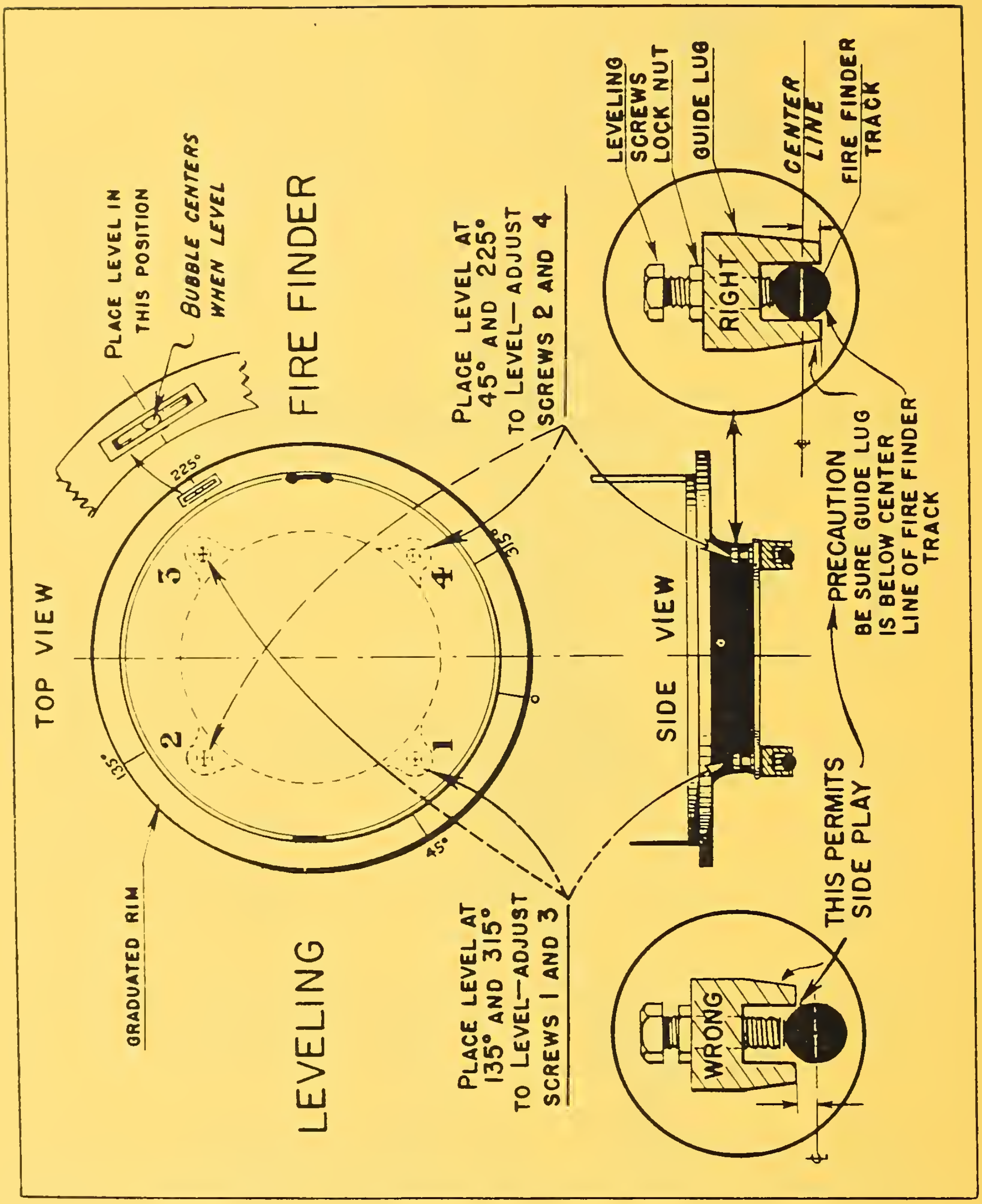


Figure 2.--Leveling the firefinder.

Checking rear sight slot to see if vertical: finder has been leveled; hair on front sight is plumb. Look through rear sight at small dot or point on the wall; raise eye slowly from bottom to top of slot. If dot is visible from bottom to top, rear sight is vertical. Report to FMO if slot is not vertical.

c. Orienting Firefinder. This should be done daily. Firefinder has been leveled, cross hairs are plumb. A designated orientation point has been selected by the FMO and the bearing recorded and posted in the lookout house. If this point does not check, the firefinder must be oriented in the following manner.

Loosen orientation adjustment screws below the upper plate of firefinder. See N, figure 1.

Set vernier at correct reading of orientation point.

Revolve, not the sights, but the entire plate of the instrument until sights are trained on orientation point.

Tighten screws below plate of finder.

Finder is then oriented.

d. Orienting Map Disk. This should be done daily. Finder has been leveled and oriented.

Set vernier at correct reading or designated orientation point selected by the FMO. Locate this orientation point on your firefinder map. If the steel tape does not pass directly over the orientation point on the map, the disk is not oriented. Then follow these steps: loosen flat head screws around outer edge of map; resolve the map disk until the orientation point shown on the map lies directly under the steel tape; clamp disk in place by gently tightening the flathead screws being careful that the position of the disk is not disturbed in the process; repeat operation using a second and third orientation point to recheck. Notify the FMO if the map cannot be oriented within 15' (minutes) on at least three orientation points.

e. Adjusting Distance Tape. Distance tape is suspended between front and rear sights by adjusting screws.

Adjust screws at either end of tape so that "0" point on the tape will be directly over the center pin. See tape G, figure 1.

Be careful--too much tension on the tape will spring the sight ring and cause it to turn hard.

2. Care of Firefinder (Figures 3 and 4).

a. Keep the firefinder clean. Use solvent if sticky or rusty and a powdered cleanser for general cleaning. Polish all brass parts.

b. The firefinder is not intended to be a table. Do not use it as a place to set cups, astrays, binoculars, clothing, or books. Use the shelves of the firefinder stand for storing items such as binoculars, instruction booklets, pencils, diary and log book, records, and first aid kit. Keep the items on the shelves neatly arranged.

c. Keep a thin coat of light oil or graphite on tracks and sight ring to prevent wear and rust.

d. Map should be kept clean and in good condition. If a new map is needed, notify the FMO.

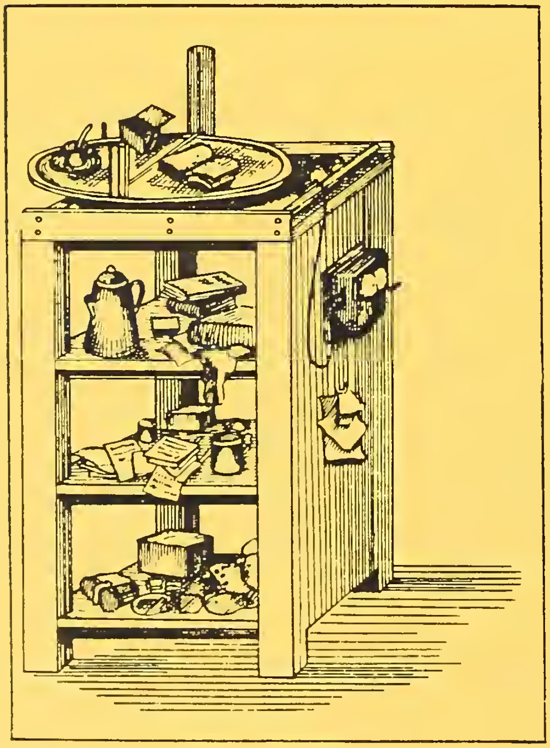


Figure 3.--Improper use.

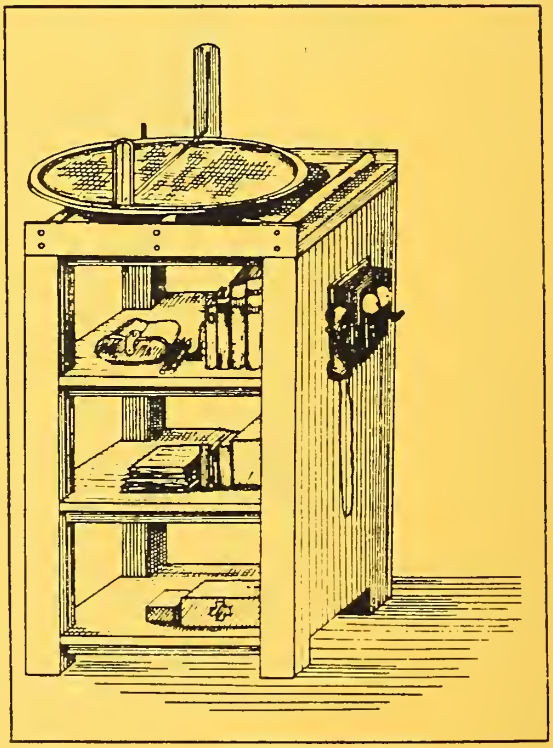


Figure 4.--Ready for use.

e. Before closing the station, protect the finder as follows: clean thoroughly, coat all metal parts with mineral oil, release tension on cross hairs and distance tape; and remove map and store in dry place or send it to headquarters, as directed.

3. How to Use Osborne Firefinder. The Osborne Firefinder measures angles to smokes in a manner similar to compass readings. These angles are known as horizontal angles and vertical angles. The horizontal angle is called the azimuth and is measured from the north in a clockwise direction. The azimuth circle is graduated into 360 degrees with true north indicated by 0. The horizontal angle, or azimuth, is more important than the vertical angle in cases where two or more lookouts see the fire. Vertical angle readings are helpful where only one lookout can see the fire. Azimuths are read from the graduated azimuth rim around the firefinder, and vertical angles are read from the scale on the rear sight.

The azimuth circle, or the rim around the outside of the finder plate, is marked with degrees and fractions of degrees, 0 (zero) on this rim, when the firefinder is properly oriented, is on the south side of the rim. This has been done for convenience in reading the azimuth. If the figures were placed in their true position, it would be necessary to go around the finder to the opposite side in order to take the reading, thereby consuming valuable time. Figure 1 pictures the Osborne Firefinder, illustrating the different parts referred to in the following paragraphs.

The proper procedure in using the firefinder is as follows. When a fire is spotted, turn the sighting ring (D) by use of handle (J). The lookout's eye should be within 2 inches of rear sight (H). Line up the vertical hair of front sight (A) and the slot in back sight (H) so that vertical hair appears in the center of the fire. Readings can now be made. (Slide firefinder on tracks or move to other set of tracks to give clear line of sight around obstructions such as corners of buildings, stovepipe, or window frame.)

a. How to Read Horizontal Angle or Azimuth. Proper azimuth readings are made as shown in figure 5. The vernier plate is attached to the movable sighting ring and is used to read the azimuth, not only in degrees, but in fractions of degrees. A degree is divided into smaller divisions known as minutes. There are 60 minutes in a degree. The symbol for degree is °. Twenty-one degrees and 30 minutes is abbreviated 21° and 30'. Look at the azimuth graduation in figure 5. Note that 0 rests between 21° 30' and 22°. In

order to find how many minutes past 21° 30' the marker lies, look toward the left until a line of the vernier coinciding with a line of the azimuth graduation is seen. Note that the line on the vernier that does coincide with a line on azimuth graduation is 15. The vernier is graduated in minutes, so add 15 minutes to 21° 30' to get 21° 45'.

Try for accuracy and speed in taking your "shots" as time is precious in fire control. By studying the country and using the orientation charts, a lookout should become proficient in the use of the firefinder.

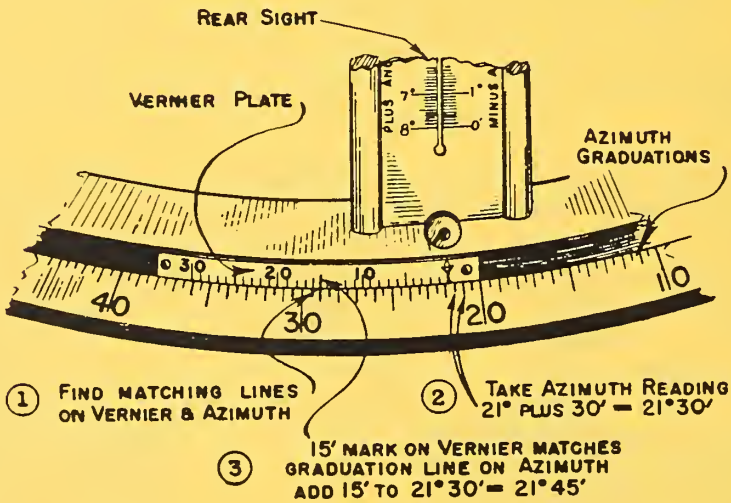


Figure 5.--Vernier plate on Osborne Firefinder.

b. Obtaining Vertical Angle Reading. The vertical angle is measured by the sliding metal piece on the rear sight. Figure 6 shows a closeup of the rear sight mechanism. There are two sets of figures marked on this sight; one reads "Plus angle read from top hair" and the other reads "Minus angle read from bottom hair."

Adjust the sliding peephole so that it rests on 0 at the bottom of the right hand or minus scale and look through the peephole. The bottom cross hair should appear in the center of the peephole. All objects sighted with the sight in this position are on the same level as the lookout point; subsequently, as the peephole is raised, other objects seen (using bottom cross hair) are below the elevation of the lookout.

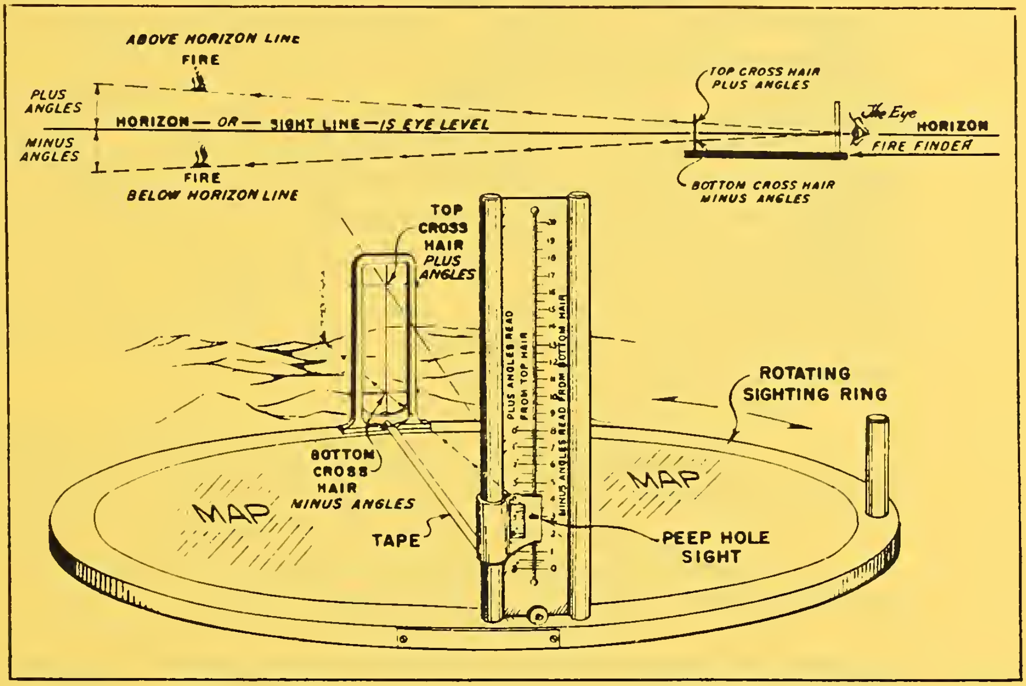


Figure 6.--How to read vertical angle.

To sight objects above the level of the lookout, the left hand or plus scale and top cross hair are used. Sighting through the peephole with the marker at the upper 0, one can see that objects seen through the top cross hair are also on a level with the lookout; but as the peephole slides downward, objects seen are above the lookout level.

The vertical reading pictured in figure 6 (using bottom hair scale) is -3°. Each mark between numerals is 10 minutes. The minus figure (-) indicates that origin of the fire is below the lookout level. Most of the readings will be a minus figure as fires generally start at the lower, more heavily used elevations below the lookout point.

c. Using Metal Tape. The metal tape stretched across the center of the map on the Osborne Firefinder is used to estimate distance of a fire from the lookout point. The first mark near the center of the tape should be directly over the pin in the center of the map. The scale on the tape is in inches, thus on a 1/2-inch scale map a fire estimated to be 3 inches from the tower (on the map) would be 6 miles from the tower (on the ground). Sometimes it is very necessary that the distance to a fire be given to the dispatcher, as in the case where only one lookout can see the fire.

d. Panoramic Photographs. The panoramic photograph is a valuable aid in locating, and describing the location of, fires. Each photograph carries a horizontal reference line corresponding to the elevation of the lookout station from which it was taken. It shows on the upper margin the azimuth angles corresponding to the azimuth circle on the firefinder at that station. A vertical angle scale is provided to define the line of sight and to read the vertical angle in reference to the horizontal line. The entire seen area of each station is covered by 1 to 3 photographs. Each photograph should be neatly and accurately labeled with the names of all the principal topographic features, such as streams, drainages, peaks, and ridges.

e. How to Determine Size of Fire by Use of Firefinder. A lookout can determine the approximate size of a large fire, if both sides of it can be seen.

Take accurate azimuth reading to each edge of fire. Use vernier to give reading in minutes.

Subtract to find the azimuth difference between readings, and then convert the difference to minutes. (1 degree = 60 minutes.)

Multiply the number of minutes by 1.5, and the result by the number of miles from the lookout to the fire.

The final result will be the distance in feet, between the two edges of the fire at right angles to the line of sight.

Estimate the other dimension of the fire, and size can be computed. Another lookout may see the other dimension and be able to compute its width (figure 7).

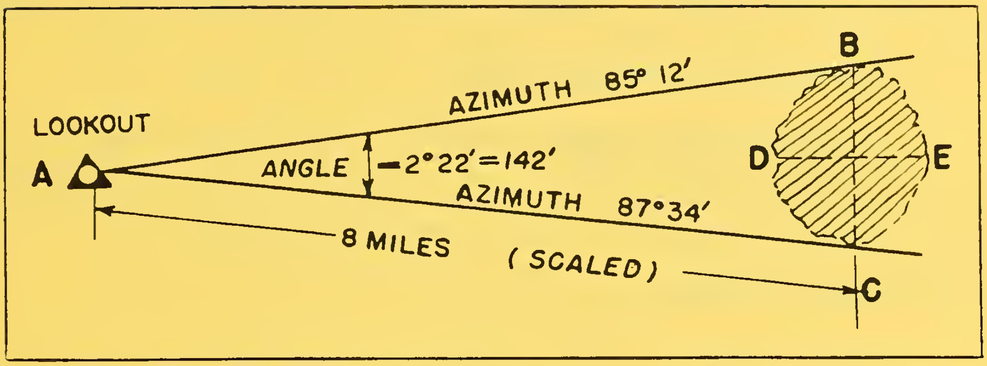


Figure 7.--How to determine size of fire.

A = Lookout station
AC = Azimuth reading, right edge of fire 87° 34'
AB = Azimuth reading, left edge of fire 85° 12'
Difference between azimuth readings 2° 22'
2° 22' converted to minutes = (2° x 60) + 22' = 142'
AC = 8 miles (scaled by metal tape on map)
Apply rule: Number of minutes x 1.5 x number of miles
Insert values: 142' x 1-1/2 x 8 = 1,704 ft which is width of fire
Distance DE - estimated to be 800 feet

$$\text{Area of fire} = \frac{1{,}700 \times 800}{43{,}560} = 31 + \text{acres}$$

Note: 43,560 is the number of square feet in an acre.

34.11f - Reporting Fires. When you see what appears to be a smoke, you must decide whether it is a false or real smoke. If it is a real smoke, is it a legitimate or illegitimate fire? These decisions must be made quickly and accurately and an immediate report made if a fire is starting. If you have any doubts about your decisions or what you have observed, you should report to the dispatcher immediately, giving all the facts. Don't take any chances. It is better to report a false alarm than miss prompt attack on a potentially big fire.

The Lookout Report should be prepared as soon as the decision is made to report a fire. In item (13) of Lookout Report, show this time as "Time Sighted" (figure 1). Fill in items 1 through 5. Report immediately to the dispatcher the data in these 5 items. Dispatcher will give each report a number, and will request other data as needed. Record items 6 through 11 after the first report.

FIREFIGHTERS GUIDE

Following are detailed instructions for completing Lookout Report:

Item (1) Station Reporting

The name of the lookout station. (A supply of report forms with this item filled in should be kept ready for immediate use on each firefinder stand. These forms should be carefully stored at the station when completed.)

Item (2) Azimuth

Record angle to nearest minute. The azimuth or horizontal angle is read on the firefinder. See "How to Obtain Horizontal Angle Reading."

Item (3) Origin of Smoke Sighted

Check "YES" if the actual starting point of fire can be seen; or if smoke can be seen rising through the timber cover at origin of the fire.

Check "NO" if neither of above is true.

Item (4) Vertical Angle

Record to nearest 10' (10 minutes), which is the small graduation on vertical scale. See "How to Obtain Vertical Angle Reading." Vertical angle reading will not be taken if origin of smoke cannot be seen.

Item (5) Location by Local Landmarks

Describe location of smoke by generally known landmarks. Use accepted local names. Example: "On small flat east side of Bear Creek, 1/2 mile below Red Bridge."

Report items 1 through 5 to dispatcher and stop. This will clear telephone or radio circuit to start action if dispatcher desires to do so. Dispatcher will request additional information as needed.

Item (6) What is Burning

Put check mark after the term best describing what is seen or believed to be burning. If not described above, describe what is seen after "Other."

Item (7) Appearance of Smoke

Check one best descriptive term under each heading of Volume, Color, Character. See "How to Identify Smoke."

Item (8) Direction from which Smoke is Drifting

Enter one of the eight main points of the compass from which the wind is blowing at the fire. Examples: NE, E, SE, S. Wind direction is always recorded as the direction from which the wind is blowing, or from which the smoke is drifting.

Item (9) Distance to Fire

Report to nearest 1/2 mile the distance from the lookout to the fire. Use metal tape scale. See "How to Use the Metal Tape."

Item (10) Size (Estimated)

Report in acres if more than 1 acre.

Report to nearest 1/4 acre if less than 1 acre. See "How to Measure Size of Fire with Firefinder."

Item (11) Location of Fire--Township, Range, Section

This is the map location by legal subdivisions. Enter the estimated location.

Time Blocks

Time should be recorded in 24-hour clock time--(See Code 13).

Item (12) Origin

Dispatcher will give these data as time allows.

Item (13) Sighted

Enter time and date the illegitimate fire was determined as reportable. Sign the report.

Item (14) Reported

Enter time and date the report to the dispatcher was completed. Enter to whom reported.

LOOKOUT REPORT OF *Slate Mountain*
(Name of Fire)

Always Report Items No. 1 thru 5

(1) STATION REPORTING *High Mtn Lookout*

(2) AZIMUTH *91° 30'*

(3) BASE OF SMOKE SIGHTED Yes ✓ No ____

(4) VERTICAL ANGLE *-1° 30'*

(5) LOCATION BY LANDMARKS *West slope of Slate Mountain near top.*

Report Items No. 6 thru 11 as Requested

(6) WHAT IS BURNING Check best descriptive term:

Grass ____	Reproduction ____	Vehicle ____
Brush ____	Slash ____	Unknown ____
Timber ____	Building ____	Other ✓

Appears to be a single snag. (Specify)

(7) APPEARANCE OF SMOKE Check best descriptive term:

VOLUME	COLOR	CHARACTER
Small ✓	White ✓	Thin ✓
Medium ____	Gray ____	Heavy ____
Large ____	Blue ____	Billowy ____
	Black ____	Drift Smoke ____
	Yellow ____	Blanket Smoke ____
	Coppery ____	(Other) *increasing column.*
	____ (Other)	(Such as puffs, column, increasing or decreasing)

(8) DIRECTION FROM WHICH SMOKE IS DRIFTING *calm*

(9) DISTANCE TO FIRE *3* miles

(10) SIZE (Estimated) *spot on single snag*

(11) LOCATION OF FIRE T *25 N* R *11 E* Sec. *18*

Always record

		DATE	TIME		
(12)	ORIGIN	*6/15/25*	*1402*	Known ✓ Guess ____	
(13)	SIGHTED	*"*	*1402*	By *Dave*	
(14)	REPORTED	*"*	*1402*	To *Insp Quick*	At *Knight Creek R.S.*

(Over)

Figure 1.--Sample Lookout Report

Reporting Procedure for Initial Fire Report

a. Condition. A lookout at Rocky Butte glances up while getting dinner to make a general observation of the country. Her eyes are attracted immediately to a small smoke rising over a ridge where she knows there are no legitimate smokes. Binoculars are used for closer scrutiny and for picking out terrain features.

b. Action Required. Lookout steps to firefinder and trains her sights on the center of the small smoke. She reads the azimuth to the closest minute and enters it on the Lookout Report form which is ready in place on a clipboard hanging on the firefinder stand. She cannot see the origin of the smoke so can take no vertical angle shot. She knows the smoke is behind Granite Ridge. She enters item 13--time sighted, and then items 1 through 5 on the Lookout Report form, calls her dispatcher on the radio immediately and reports: "One, - Rocky Butte, Two, - 87° 30', Three, - No, Four, - None, Five, - West side Granite Ridge." Dispatcher acknowledges and gives report number and time. The time is 12:14 p.m. recorded in 24-hour clock time (see appendix). Lookout enters this time as "reported" time. She completes additional data for items 6 through 11 on Lookout Report. She also enters the required information in the Daily Log and Diary.

c. Why. Houskeeping work did not interfere with general observations. She picked up the smoke quickly because it was unusual and out of place. Immediate, accurate reporting to dispatcher ensures prompt initial attack. Written report data ensure good records.

Reporting Procedure in Case of Communications Failure

a. Condition. Lookout sights illegitimate smoke. She locates smoke with firefinder and makes proper entries on Lookout Report. She first tries to report the smoke by radio, but cannot reach any station. She next tries to telephone the dispatcher, but cannot make contact.

b. Action Required.

(1) She calls nearest fire station by telephone.

(2) She makes her report to the person at this station. This person can relay report by radio from the station or take some other action to get report to dispatcher.

(3) Lookout checks all external connections on her radio. After some delay, she finds loose battery connection which she repairs. She makes radio contact with dispatcher and gives the second report on fire; also reports telephone trouble.

c. Why. It is most important to get the fire report to someone on the ground who can take action. Do this first if possible then check equipment for trouble. The second report to dispatcher will confirm the relayed message.

Reporting Procedure During Lightning Storm

a. Condition. A general lightning storm develops during the night and moves in during the morning, arriving over the lookout at noon.

b. Action Required. Lookout reports the general condition to his dispatcher as soon as observed in the morning. He reports lightning seen at 20 miles at 1030. He records lightning strikes observed, by azimuth and local landmarks. At 1205, he reports storm 1 mile distant, pulls his telephone disconnect switch, and disconnects radio antenna as instructed. He stays in building, away from metal objects, such as firefinder, stove, or metal bed, and does not use radio while storm is in progress overhead.

When storm has passed, he activates and tests the telephone line and radio by check call to dispatcher. He carefully observes the areas of lightning strikes for several days. On the second day he picks up a small smoke from a sleeper fire and reports it to the dispatcher.

c. Why. Lookout keeps dispatcher informed of approach and progress of storm. Conforms to all safety procedures required during lightning storms. From record of strikes is able to give special attention to danger areas and can pick up a sleeper fire before it becomes large.

After reporting a fire or smoke, enter the following in Daily Log and Diary: time reported, azimuth and vertical angle; name of person and station to whom reported; and name of fire as soon as it is identified.

Lookouts should record all smokes in either the logbook or on the individual "Lookout Report on Fires" form. The FMO will advise which one to use.

34.11g - Action During Lightning Storms

1. Unless instructed otherwise, when a thunderstorm approaches to within 30 miles of the tower, make the following report to dispatcher: name of station; intensity of storm, mild (consists of 2 or 3 thunderclaps and only cloud lightning), moderate (produces sharp thunderclaps with several lightning strikes to the ground in addition to much cloud-to-cloud activity), severe (accompanied by almost continuous thunder and cloud-to-cloud lightning with many ground strikes).

2. Lookouts should always provide forces on going fires with advance warning of thunderstorms and squall lines (a line of thunderstorms or showers accompanied by strong gusty winds) approaching a fire area. Erratic fire behavior is to be expected from these, and information on their approach may alter control action to provide for extra safety.

3. Watch continually for strikes. Every lightning bolt which strikes the ground is a potential fire.

Every lightning strike which goes to ground within the seen area day or night should be observed and recorded by time, azimuth, location, and vertical angle, if possible (figure 1). If time permits, these should be shown on the firefinder map with a red cross. A "grease" pencil is ideal for writing on map discs treated with clear plastic.

Frequently, strikes occur in such rapid succession that time is not available to secure and record complete information on each. In such cases, an attempt should be made to observe all strikes and record as much information as possible. When strikes occur at the rate of several per minute, a systematic method must be used to secure even the minimum information. One good method is to place a paper disc under the map to the inside edge of the sight ring. As a strike occurs, the sight ring can be quickly spun to position and mark placed directly under the tape near the rear sight. If time permits, a numeral can be placed near the line to represent distance. The azimuth can be taken later, and as much other information recorded as the observer can recall. Marks can be erased for these strikes that develop into fires and for which complete reports have been made. Marks remaining will serve as ready reminders of strikes which should be carefully scrutinized for at least 5 days after the vegetation has dried out. This method could be used to segregate and record strikes from more than one storm by using a different colored pencil. The distance from the lookout station to the point of strike can be calculated roughly by counting the number of seconds between the flash and the report of thunder following. The distance equals approximately 1,100 feet for each second elapsing, or 1 mile for each 5 seconds.

LIGHTNING STRIKE RECORD

On June 15 1985

High Mountain Lookout Ponderosa National Forest General Area Granite Basin

(As So. Slope Black Fox, Lyell Mt)

Time of Strikes	Azimuth Reading	Vertical Angle	Miles Distant	Fire is located with respect to: Direction	Distance	Named Landmark	It is: A Spot	Small	Large	Can he see it direct	Is it over intervening ridge	It is burning: Single Snag	On Ground	In Brush	Where	Smoke appearance: White	Black	Thin	Other
1402	91° 30'	-1° 30'	3	West Slope	Near Top	Slate Mtn.	✓			Yes ✓ No	Yes No ✓	✓				✓			
1403	98° 00'	-1° 00'	3	North End	Just over top	Slate Mtn.	✓			Yes No ✓	Yes ✓ No					✓		✓	
1403	97° 30'									Yes No	Yes No								
1405	91° 00'									Yes No	Yes No								
1407	87° 30'									Yes No	Yes No								
1410	103° 30'									Yes No	Yes No								
1410	78° 00'									Yes No	Yes No								
1411	72° 30'									Yes No	Yes No								
1411	70° 00'									Yes No	Yes No								
1412	65° 30'	-3' 30'	6	North	1/2 Mi	Rock Creek Camp	✓			Yes ✓ No	Yes No ✓			✓			✓		
1415	71° 30'									Yes No	Yes No								
										Yes No	Yes No								
										Yes No	Yes No								
										Yes No	Yes No								
										Yes No	Yes No								
Col (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	16	(17)	(18)	(19)	(20)

Total No. of Strikes 11

Signature Hugh R. Lowe

Figure 1--Sample lightning strike record.

4. When lightning storm is near or overhead, observe the following safety rules.

a. Stand on insulated glass-legged stool.

b. Do not use telephone. Use rope to throw telephone line switch.

c. Do not use radio.

d. Keep doors and windows closed. Lightning follows air currents.

e. Put out fires in stoves when severe storms approach.

f. Stay inside the protected house.

g. Keep a poster on lightning safety rules displayed for ready reminder.

5. When storm has passed, reestablish communications by telephone or radio with your dispatcher or headquarters.

6. Use the information on location of strikes gathered during the storm to try to discover smokes at these locations after the storm.

7. Watch the area of all strikes intensively for a period of at least two weeks after the storm. Lightning fires frequently smoulder for days before they send up enough smoke to be seen. These have been termed sleeper fires and are particularly dangerous because of their likelihood of spreading rapidly as a result of the vegetation drying out. They often show up during the worst burning conditions. The best time for effective observation is usually early the next morning following the storm. Take full advantage of this period and watch carefully the locations of all observed strikes as well as the entire area over which the storm passed. Frequently, a direct lightning hit results in a puff of smoke, dust, or steam. This does not necessarily mean that a fire has been established, but if it continues to show for more than 2 minutes, it should be assumed to be a fire and reported as such.

34.11h - Safety Hints

1. Use a flashlight when going upstairs or downstairs at night.

2. Keep inside trapdoor to stairs closed, except when stairs are in use.

3. Keep catwalk trapdoors closed, except during heavy visiting periods. When catwalk trapdoors are open, be sure the bar at the open end of stairwell is in safety position.

4. Warn visitors of the danger of falls and see that children are not allowed unattended on catwalk.

5. Keep catwalks and stairs free of chairs, boxes, tools, and all other objects.

6. You will be supplied a copy of the unit safety rules. It is your responsibility to study this material and to do your job safely.

7. Fill gasoline lanterns outside the building.

8. Never fill gasoline lantern when lighted or warm; always fill during daylight hours.

9. Never start fires in stove with gasoline or kerosene.

10. Store administrative equipment where it will be safe from the weather and vandalism.

34.12 - Patrol. There are times when it is advantageous to use a patrol system for discovering fires. High risk in certain areas not readily seen from lookouts, or when visibility is poor because of smoke or other atmospheric conditions are examples.

If assigned to patrol, a lookout will be given a route by the dispatcher. Take advantage of openings and viewpoints to look for fires. Instructions to lookouts for finding and reporting fires will be helpful. A compass will be used to determine bearing or azimuth. Accuracy will be improved if the lookout:

1. Knows the country well.

2. Knows own location at time fire is discovered.

3. Knows reporting procedure. (Mobile communication difficulties may require use of special local procedures.)

A word of caution: Drive safely--stop to make observations. Watch for other vehicles.

When talking with forest users, let them know what you are doing. Enlist their aid. Many fires are reported by forest users and visitors.

34.2 - Aerial Detection. This is a detailed operation requiring special equipment, abilities, and training. Aerial detection is coordinated with ground detection.

In some areas aerial detecting has increased in use as ground detection has been reduced. It is commonly used on high danger days and after lightning storms, as a supplementary measure, in many parts of the country. Aircraft used are normally high winged planes, helicopters, or a combination of the two.

FIREFIGHTERS GUIDE

CHAPTER 40 - FIRE BEHAVIOR

Contents

CHAPTER 40 - FIRE BEHAVIOR

See definition at end of chapter. Each firefighter should know and understand the fundamentals of fire behavior. This is necessary for your own and others' SAFETY in firefighting.

The factors that make a fire burn, make it spread and increase the rate of spread and the direction of spread are important parts of fire behavior.

Many things influence fire behavior, only the basic factors will be described here. Additional and more complete information will be furnished firefighters if necessary for further training.

41 - HOW FIRE BURNS. When enough heat is applied to a fuel, fire results (figure 1). It is the result of a rapid chemical combination of fuel and oxygen. Heat is necessary to begin the reaction.

Once started, fire produces its own heat. Wildland fires originate from such sources of heat as sparks and embers from cigarettes, campfires, arson, trash fires, railroad locomotive exhausts, and lightning.

Fire cannot exist in the absence of heat, fuel, or air. The basic principle of fire suppression is to remove heat or fuel or air in the quickest and most effective manner.

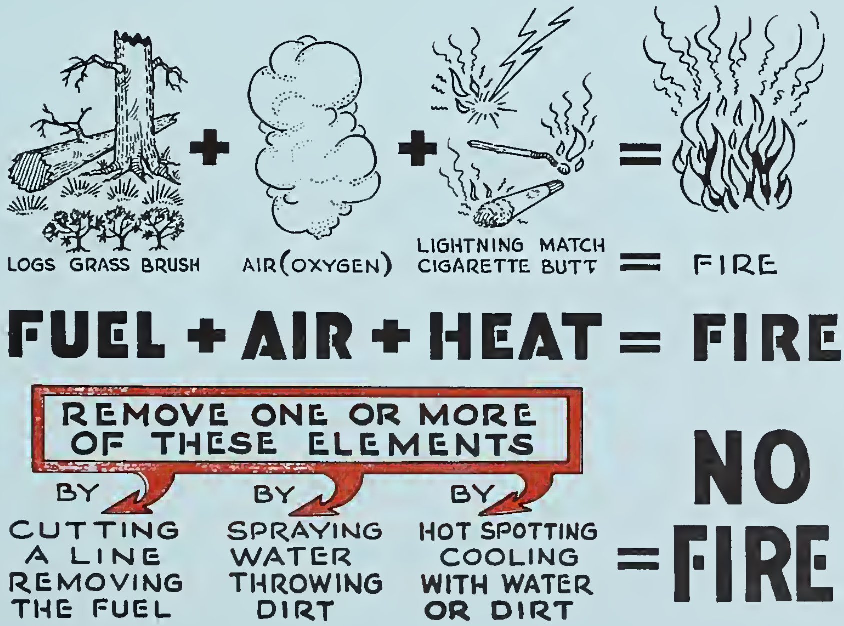


Figure 1.--How a fire burns.

42 - WHY FIRE SPREADS. There are many causes and reasons for fires acting as they do, but the primary factors which influence the spread of fire are: fuel, weather, and slope (figure 1).

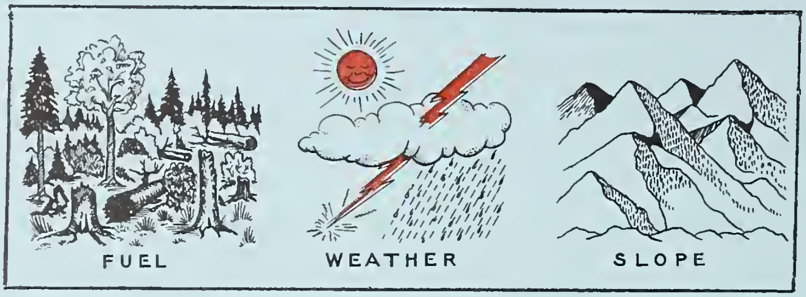


Figure 1.--Why a fire spreads.

42.1 - Fuels. Fuels are commonly divided into two main groups: light or fast-burning fuels make up one group--dry grass, dead leaves and tree needles, brush, and small trees (figure 1). Light fuels cause rapid spread of fire and serve as kindling for heavier fuels. Some green fuels such as tree needles, chamise, gall berry-palmetto, ceanothus, and other brush types have a high oil content and are fast burning when they are not in the active growing stage.

Heavy or slow-burning fuels are the second group--stumps, logs, branch wood, and deep duff (figure 1). Duff is the top soil or partly decayed leaves and tree needles found under dense stands of brush or trees. Dry, heavy fuels burn readily and produce large amounts of heat.

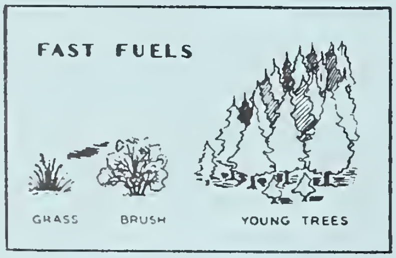


Figure 1.--Rapid spread.

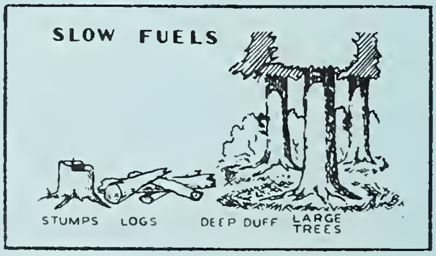


Figure 2.--Slow spread unless weather is extremely dry and windy.

42.2 - Weather. Weather factors with which a firefighter is concerned are: wind, moisture, and temperature (figure 1).

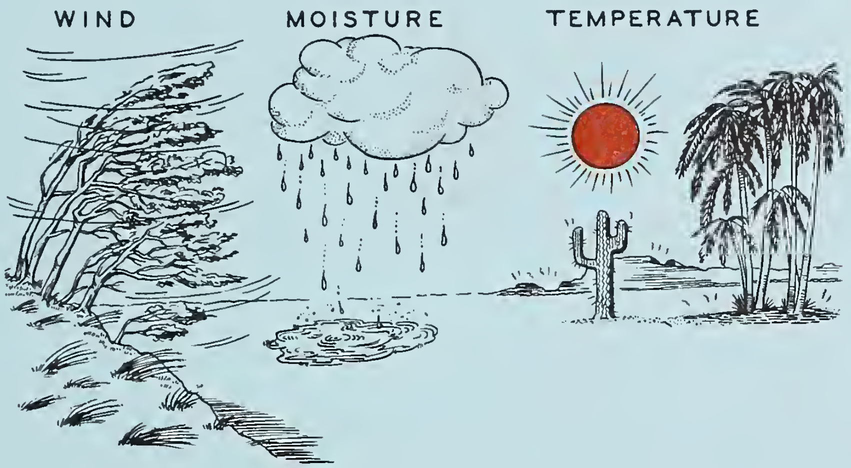


Figure 1.--Weather factors.

1. Wind. The stronger the wind, the faster the spread of fire (figure 2). This is true because wind brings an additional supply of oxygen to the fire, directs the heat (flame) toward the fuel ahead, and causes spot fires by blowing sparks and embers ahead of the main fire into new fuel.

Figure 2.--Wind.

Fire itself causes local air currents that add to the effect of the prevailing wind on fire spread. The air above the flames becomes heated and rises (figure 3). Then fresh air rushes in and helps the burning. Generally, the wind is gentlest from 0400 to 0700. As heat from the sun warms the ground, the air next to the ground is heated and rises. So air currents usually flow up the canyons and slopes during the day. During the evening and night the ground cools and the air currents reverse their direction and

flow down the canyons and slopes. The direction of canyon and slope wind flow should be remembered when planning the attack on a fire--normally--wind blows up the canyon by day and down at night. The "Beaufort Scale of Wind Velocity" is helpful in determining wind speed (figure 7).

Figure 3.--Heated air rising.

2. Moisture. Moisture in the form of water vapor is always present in the air (figure 4). The amount of moisture that is in the air affects the amount that is in the fuel. The moisture content of fuels is an important consideration in firefighting since wet fuels, and most green fuels, will not burn freely. Air is usually drier during the day than it is at night. Fires, then, burn more slowly at night, under normal circumstances, because moisture is absorbed by the fuels from the damper night air. This is particularly true of fuels such as dry grass, tree needles and small twigs.

Absorption of moisture by the fuels, down slope winds, lower temperatures, and other day-night weather differences generally aid the firefighter at night. This is why a fire may burn out of control in the afternoon and yet may be handled by the same crew at night. Every effort should be made to completely surround (confine) and permanently stop (control) a fire before burning conditions build up the following day.

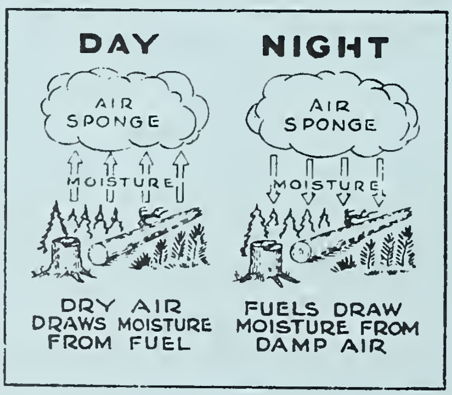


Figure 4.--Moisture.

This does not mean that no attempt should be made to suppress fires during the day. Most fires are controlled during the day. When this is not possible, major effort must be made at night (figure 5).

3. Temperature. Air temperature affects firefighting. Fuels preheated by the sun burn more rapidly than do cold fuels (figure 6). The temperature of the ground also affects the movement of air currents, as explained previously.

Temperature also has a very direct effect upon the firefighters themselves. It is more uncomfortable and tiring to fight fires in excessive heat.

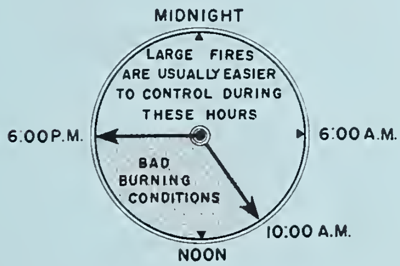


Figure 5.

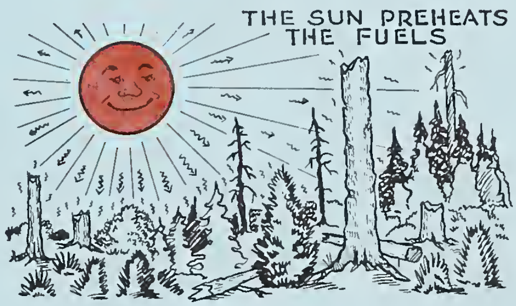


Figure 6.

SCALE OF WIND VELOCITY

Figure 7.

42.3 - Slope. Slope greatly affects the spread of fire in two ways: by preheating and draft (figure 1). A fire will run faster uphill than it will downhill if the wind is not strong enough to otherwise influence the spread. On the uphill side the flames are closer to the fuel. This causes preheating and faster ignition. Heat rises along the slope causing a draft which further increases the rate of spread.

On steep slopes burning chunks of fuel may roll downhill starting new fires.

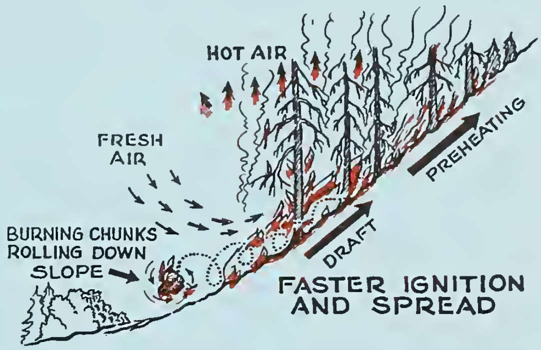


Figure 1.--Slope.

43 - FIRE DANGER. Key stations determine the fire danger daily and keep the fire control organization informed. Each firefighter should know the current fire danger.

43.1 - Fire Danger and Fire Behavior. There are five recognized fire danger classes:

1. Low. Fires do not start readily from most accidental causes, though many lightning fires may start in some areas during low-danger periods. Fires which do start generally spread slowly, and there is little tendency for fires to spot. They often do not burn clean, but spread in irregular fingers.

2. Medium. Fires can start from most accidental causes, but the number of starts is generally low. Rate of spread of fires is moderate; heavy concentrations of fuel will burn hot, and there may be some spotting. Control of fires during this period usually presents no special problems.

3. High. Fires will start easily from most causes. Fires will burn hot, spread rapidly, and will spot readily. Control of fires may become difficult, unless they are hit hard and fast while small.

4. Very High. Fires start easily from most causes. Fires will develop fast and can spread at high rates of speed with considerable spotting. Direct attack at the head of a fire is rarely possible after it has been burning a few minutes.

5. Extreme. Fires start easily from all causes and may be started by unusual or unexpected causes. Fires burn intensely and spread rapidly. Direct attack is rarely possible except when fires are still small. The running heads of large fires are usually uncontrollable while the extreme danger period lasts and most effective control work must be confined to the flanks of the fires and to well-planned strategy.

43.2 - Lightning Fires. No general rule can be made to correlate the occurrence of lightning fires with the class of fire danger. In some areas, lightning fires may even start when the danger is low. A fire may start during a storm when the danger is temporarily in a lower class. Later the danger may go right back up after the storm passes over, especially if the storm is "dry" or the rainfall is light. Lightning fires that do start behave and spread as any other fire.

43.3 - Work Schedule. A firefighter's work plans and days off are affected by the fire-danger rating of any day. Fire prevention becomes especially important on days of high, very high, and extreme fire danger. Efforts must be intensified to prevent fires from starting on these days. If fires do start, quick attack is necessary, and it is necessary to work harder to catch these fires while they are still small.

The daily fire danger rating and the weather forecast are used to predict tomorrow's fire danger. You may be ordered to work on your regular days off when fire danger is predicted to be high or above.

FIREFIGHTERS GUIDE

CHAPTER 50 - FIRE SUPPRESSION

Contents

CHAPTER 50 - FIRE SUPPRESSION

Suppression is all the work of extinguishing or confining a fire, beginning with its discovery. Suppressing a fire, or firefighting, is usually difficult work with inherent danger. However, knowing and applying safety principles and firefighting tactics will ensure safe and effective work.

51 - TEN STANDARD FIREFIGHTING ORDERS.

Every Fire Management employee who will have firefighting duties will learn the standard firefighting orders and follow each order when it applies.

1. Keep informed on fire weather conditions and forecasts.

2. Know what your fire is doing at all times.

3. Base all actions on current and expected behavior of fire.

4. Have escape routes for everyone and make them known.

5. Post lookouts when there is possible danger.

6. Be alert, keep calm, think clearly, act decisively.

7. Maintain prompt communication with your crew, your boss, and adjoining forces.

8. Give clear instructions and be sure they are understood.

9. Maintain control of your personnel at all times.

10. Fight fire aggressively, but provide for safety first.

51.1 - Fire Situations that Shout "Watch Out."

1. You are building a fireline downhill toward a fire.

2. You are fighting fire on a hillside where rolling material can ignite fuel below you.

3. You notice the wind begin to blow, increase or change direction.

4. You feel the weather getting hotter and drier.

5. You are in heavy cover with unburned fuel between you and the fire.

6. You are away from a burned area where terrain and/or cover makes travel difficult and slow.

7. You are in country you have not seen in the daylight.

8. You are in an area where you are unfamiliar with local factors influencing fire behavior.

9. You are attempting a frontal assault on a fire with tankers.

10. You are getting frequent spot fires over your line.

11. You cannot see the main fire, and you are not in communication with anyone who can.

12. You have been given an assignment or instructions not clear to you.

13. You feel like taking a little nap near the fireline.

51.2 - Four Common Denominators. There are four major common denominators of fire behavior on tragedy and near-miss fires. Such fires often occur:

1. On relatively small fires or deceptively quiet sectors of large fires.

2. In relatively light fuels, such as grass, herbs, and light brush.

3. When there is an unexpected shift in wind direction or in wind speed.

4. When fire responds to topographic conditions and runs uphill.

Yet, these factors should not be considered all-inclusive. A sudden change of wind, and the fire may change direction, regardless of the topography.

Each set of circumstances has the potential for creating a tragedy or near-miss fire. Often, human behavior is the determining factor. The firefighters who "keep their cool" when the wind direction changes and move back into a burned area will survive. The people who panic and try to outrun a fire under similar conditions may die. The difference between a tragedy fire and a near-miss fire may be due to luck, skill, or advance planning. But, in all cases, it pays to be alert and aware of certain conditions that may signal a sudden change in fire behavior.

In a few words:

Be Alert. Watch Out For:

Light Fuels
Wind Shifts
Steep Slopes and "Chimneys."

The person who is always alert and on the lookout for possible trouble has the best chance of surviving.

52 - SUPPRESSION OF SMALL FIRES. Fire management policy requires prompt, safe, aggressive suppression action on all wildfires.

Small fires cause the same kind of suppression problems and require the same kind of practices as larger fires. The most effective suppression of small fires involves the following steps: first attack, line location, line construction, burning out, mopup, patrol, and declaring the fire out.

This section of the guide makes no attempt to teach or instruct in such fundamentals. What it does attempt is to depict fire suppression problems which are commonly met. Each example covers one simple, readily identified situation; indicates the action required to solve each situation; states why the solution is correct; and indicates when the same solution applies to conditions other than those assumed.

Studying the examples should help establish the habit of first sizing up the fire, looking at it as a whole; analyzing it into parts that require different action; and deciding on and using firefighting methods of proven worth on each part of the fire.

This section does not attempt to tell how to develop a plan when confronted by many problems requiring big-fire organization. It should help a firefighter decide what to do first and how to finish the job when a fire is small.

Suppression strategies range from prompt control at the smallest acreage possible, to containment utilizing a combination of fireline and natural or constructed features, to merely assuring that the fire remains confined within a defined geographical area. Your supervisor will determine the appropriate suppression strategy.

FIREFIGHTERS GUIDE

52.1 - Initial Attack.

1. Principles of Initial Attack. If you are the first person to arrive at a fire, or the person in charge of the first crew to arrive at a fire, you have several problems. You are confronted with the problem of deciding (a) what is the most important work to be done first, and (b) where the most effective work can be done. After a quick size-up of the conditions within the fire, around the fire, and in the surrounding country toward which the fire is spreading, you must choose the point of first attack.

a. Size-up Fire. Go around the fire as quickly and safely as possible, or inspect from a vantage point. However, do not go around the head of the fire if it is moving rapidly--entrapment is likely. Size-up from a vantage point or from the flanks of the fire.

What to look for:

Fuel burning adjacent to fire edge, particularly snags, stumps, logs, brush, and thickets of reproduction.

Fuels in immediate path of fire.

Natural barriers (roads, streams, or barren ground).

Slopes.

Spot fires.

Other factors to consider:

Weather conditions (wind, temperature, relative humidity).

Time of day.

Determine the following:

Danger spots where fire is likely to flare up.

The most vital point of attack.

The best tools to use for each situation.

Can people work safely?

The cause of the fire. (If person-caused, look for and preserve evidence. See prevention chapter.)

b. Select Point of Attack and Make Attack. The universal rules are: (a) take prompt action on vital point; (b) stay with the fire, and take most effective action possible with available forces and equipment; (c) inform dispatcher of situation by radio, so long as this does not interfere with control work; and (d) continue work day or night, if night work can be done safely.

2. Good Practices in Making Attack.

a. Use water or dirt for cooling down and extinguishing hot spots. Anticipate future control action when fire cannot be put out promptly.

b. Follow up temporary efforts to check fire spread by putting in a permanent, clean fireline to mineral soil.

c. Where possible, anchor initial point of line to road or natural barrier to minimize chance of being flanked by fire.

d. Construct fireline uphill from a point anchored to the fire (52.2-2).

e. Cut fire off from the most dangerous fuels as first effort, and prevent the fire from becoming established in explosive types of fuels, such as thickets of tree seedings, heavy brush, or slash areas.

f. Confine fire to one major area rather than let it develop more than one head.

g. Locate and build lines and move all rollable material so it cannot roll across firelines.

h. Leave no unburned islands or other areas of unburned material close to line.

i. To ensure control within time limits, locate and build control in easiest safest places for easy line construction that can be held. Burn out unburned area when line is constructed and burning out can be controlled.

j. Utilize existing barriers to full extent.

k. If whole fire cannot be controlled, notify dispatcher by radio, and then do some effective work on at least a part of the fire.

Where improvements (houses, other buildings, fences) are involved, consider all the facts before determining which point must be attacked first.

3. Examples of Initial Attack. The following conditions are assumed for all examples of initial attack, line location, and line construction, except as otherwise specified in individual problems:

Attacking force consists of two people or small crew.

Suitable handtools and backpack pumps needed are available, but not engines, dozers, or tractor plows, etc.

Fire danger is medium to high. Logs and snags and other fuels ignite easily, and burn hot. Fire will spread moderately fast, and will spot easily.

Time of day: Noon to midafternoon.

Dirt readily obtainable.

Portable radio available for on-the-line communication.

USE OF DIRT IN FIRST ATTACK

Figure 1.

Condition

Small hot fire burning in heavy fuels. Loose dirt available.

Action Required

Throw dirt on flaming fuel (at base of flame) to cool fire, then encircle with line at edge of fire.

Why

Permits control of fire with minimum amount of line and with maximum speed. Cooling the fire first minimizes the danger of spot fires, and building the fireline at the edge of the fire did away with the necessity of burning out to the line.

Supplemental Action

Dirt is most effective when applied rapidly. If it is difficult to obtain build up a small pile and then apply rapidly.

USE OF WATER IN FIRST ATTACK

Figure 2.

Condition

Small, fast-spreading fire in light fuels. Backpack pumps available.

Action Required

Spray water on the fuel at the base of the flame. Cool down fire, and followup immediately with clean line to mineral soil.

Why

Water spray permits rapid cooling of hot line and followup with handtools. Fireline to mineral soil must be constructed, even though water stops the fire, to prevent fire from later coming to life and spreading after the water evaporates.

Water-Use Principles

Spray is more effective than straight stream. Use only enough water to cool the fuel. Do not waste water. Use wetting agents, if available, for more effective use of water.

FIRE IN BASE OF SNAG

Figure 3.

Condition

Fire burning in fuel around base of snag, and just getting established in the base of the snag. No fire in the upper part of the snag.

Action Required

Extinguish fire in snag promptly. Use dirt or water to cool fuel. Scrape or chop out burning material with shovel or ax. Watch for falling bark or limbs.

Why

To prevent fire from enveloping snag and showering sparks into unburned area, thus causing spot fires, or increasing area necessary to include within line.

Supplemental Action

The same solution applies to down logs in which fire is just starting.

FIRE ESTABLISHED IN SNAG ABOVE BASE

Figure 4.

Condition

Continuous fuel around snag. No wind. Fire in snag burning briskly; too hot or too dangerous to fell snag. Level ground.

Action Required

Remove fuel from around snag. Be sure to cut and remove brush or reproduction for a radius sufficient to catch falling limbs or chunks. Safety Note: Be alert; avoid getting hit by falling material. After removing fuel, drop back to 1-1/4 to 1-1/2 times height of snag, clear wide line, select time, and burn out inside line. This will make a clear space to catch snag when it falls. Watch for spot fires.

Why

To prevent burning material or the falling snag from spreading fire to surrounding area, and to prevent spot fires.

Supplemental Action

Situation same as described above, with danger of spotting at a minimum. Pile heavy fuels (limbs, etc.) at base of snag to speed burning down of the snag.

FIRE IN TOP OF SNAG

Figure 5.

Condition

Fuel in moderate quantity surrounding snag. Light wind. Snag burning in top. Snag can be felled safely. Level ground.

Action Required

Remove fuel from area large enough to catch snag, and then fell the snag and extinguish all fire in it by chopping out the burning wood. Extinguish with water and dirt. Watch for spots.

Why

To get fire on ground within reach of attacking force and to prevent spot fires.

Supplemental Action

Similar action should be taken to extinguish a fire in a spike-top green tree.

Safety Precaution

Post lookout to give fallers warning of falling tops or limbs. Plan and clear an escape route and go through a practice drill, "dry run," of running to escape a falling top or limb.

FIRE SPREADING--ABOUT TO IGNITE SINGLE SNAG

Figure 6.

Condition

Uniform cover over area.

Action Required

Control edge of fire nearest snag first. Cool heavy fuels, such as logs and fallen limbs, construct a fireline around the snag temporarily by use of dirt to prevent spread of fire to base of snag.

Why

To prevent fire from getting into snag.

Supplemental Action

Same solution applies where fire is spreading and about to ignite logs, dense brush, reproduction thicket, or slash.

FIRE ABOUT TO CROWN IN REPRODUCTION OR BRUSH

Figure 7.

Condition

Fire starting to burn briskly in base of reproduction or brush thicket. Just starting to crown. Plenty of dirt available.

Action Required

Throw dirt at base of fire to cut down heat and prevent crowning, even if burning material is well within planned control line.

Why

To reduce spot-fire danger, rate of spread, and possible loss of line. Crown fire can leap across a fireline.

Supplemental Action

Remove limbs and other fuel from in front of fire to reduce heat and prevent crowning.

USE OF ENGINE IN INITIAL ATTACK

Figure 8.

Condition

Small hot fire burning in heavy fuel, spreading fast, starting to crown in reproduction or brush. Engine available.

Action Required

Attack on flank near head of fire. Apply water at base of flame and work around to encircle the head of fire. Use a spray directed parallel to fire edge. Shut off nozzle when moving between hot spots. Follow with control line to mineral soil, completely encircling the fire.

Why

Knock down flame with water to permit rapid control-line construction.

Water-Use Principle

Use of spray increases efficiency and conserves water.

USE OF TRACTOR PLOW IN INITIAL ATTACK

Figure 9.

Condition

Small hot fire burning in medium fuels in flat to gently sloping terrain. Tractor plow available.

Action Required

Tractor plows are a common initial attack resource in the eastern states. They include tractors with V-shaped plows attached to the tractor hitch, as well as units mounted on rubber tires with two coulter discs plowing a fireline. (Four disc plows are available for heavy tractors.) In either case, the purpose is to plow a line to mineral soil. Due to the variety of equipment, fuels, soils, and burning conditions, tactics are not described, but left to the employing agency.

Supplemental Action

All unburned vegetation between the line and the fire should be burned out to widen and secure the line and prevent the fire from spotting over the line.

BURNING LOG LYING ALONG THE CONTOUR OF THE SLOPE

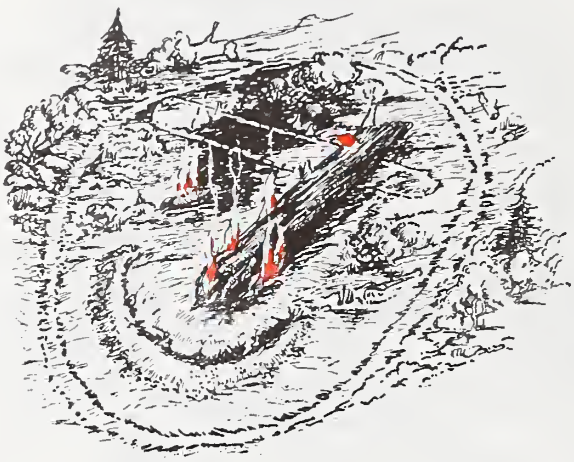


Figure 10.

Condition

Steep slope, good soil, water not available.

Action Required

Stop the spread with "scratch line," a hastily constructed, temporary fireline. Turn log around to lie uphill and downhill; roll it into prepared trench. If log is then too hot, cool it down temporarily with dirt, but do not leave it buried. Dig a trench around the lower end of log, deep enough to catch rolling embers.

Why

To prevent burning material from rolling down the slope. Cooling the fire prevents excessive production of sparks. It is not practicable to bury large logs deep enough to smother the fire. Buried logs may burn through the dirt cover later and may send sparks across the fireline.

LOWER EDGE OF FIRE LYING ALONG THE CONTOUR
OF A STEEP SLOPE

Figure 11.

Condition

Considerable material that rolls readily, such as pine cones.

Action Required

Construct a deep trench, well banked with earth on lower side, along the entire undercut portion of the fireline.

Why

To catch burning material and keep it from rolling across the control line into unburned area.

RAPIDLY SPREADING FIRE IN GRASS, NEEDLES, LEAVES, OR SIMILAR COVER

Figure 12.

Condition

Fire in light fuels and spreading rapidly.

Action Required

Use scratch line to first stop spread of fire or slap the fire edge out with shovel, McCleod, Pulaski tool, wet burlap or "flapper." Complete line after rapid spread is stopped.

Why

To permit control of fire when building of safe final line cannot keep pace with spread.

Supplemental Action

Same result can often be obtained by cooling advancing edge of fire with dirt, or by use of water. In all cases it is necessary to construct a safe final line.

USING THE SWATTER OR FIRE FLAP (FLAPPER)

Figure 13.

Condition

Fire spreading in grass, needles, leaves, or other light fuels.

Action Required

Use swatter in a swabbing motion that will cut off air from the flames. Lightly pat, swab, or rub along the fireline, moving the swatter progressively along the fireline. Do not swat or flap as this action tends to spread the fire.

Why

The smothering effect of this tool makes it effective against light fuels.

Supplemental Action

The effectiveness of the swatter is greatly increased when a backpack pump is used as followup.

SMALL FIRE IN SMALL DENSE BRUSH PATCH SURROUNDED BY AREA WHERE LINE IS EASILY BUILT

Figure 14.

Action Required

Drop back from dense brush and build line in more open cover where line can be constructed more easily and rapidly. Burn out the fuel inside the constructed line as it is built. Ensure that the fire from burning out will not get ahead of or over line being built. This is calling "firing out," "clean burning," or "burning out."

Why

To encircle fire with line that can be more rapidly built and more easily held than in brush.

Supplemental Action

Same type of problem exists if fire established in small pile of logs or slash, or dense patches of reproduction. Drop back from heavy fuel and build line in open.

FIRE BURNING NEAR SIDE OF ROAD, STREAM, OR OTHER BARRIER

Figure 15.

Condition

Uniform slope and cover.

Action Required

First control fire on side away from barrier, allowing fire to burn to barrier or toward it, until side away from barrier is safe. Note good anchor points. As line is built unburned material inside of line should be burned out.

Why

To take advantage of existing barriers and thus reduce length of line to be constructed.

Supplemental Action

It is essential clean burning be done along existing barriers before the fire is considered controlled, unless barriers are of sufficient width to ensure safety against spot fires and flaring across line.

SMALL FIRE IN ROCKY COUNTRY

Condition

Little dirt available. Water must be hauled in by vehicle or carried in on firefighter's back.

Action Required

Haul and pack water to put on fire until it is completely extinguished. Wetting agents, if available, added to water will increase its effectiveness.

Why

It is impossible to build a continuous control line in this type of country, so the only sure method to control fire is with water.

FIRE TOO BIG FOR INITIAL ATTACK TO CONTROL

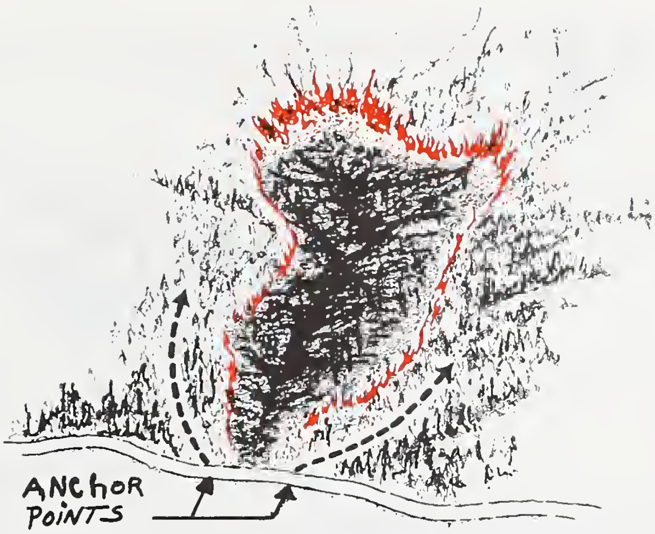


Figure 16.

Condition

Uniform cover and fire spreading fast. Fire too large and spreading too fast for initial attack crew to control.

Action Required

Report general fire situation to dispatcher by radio immediately. Scout fire to have information available when followup crew arrives. Stay with fire. Select good anchor point and begin work at rear of fire and proceed on rear and flanks until help arrives.

Why

Make time and effort effective in partial control instead of making potentially dangerous and futile efforts to head fire.

Supplemental Action

If fire can be kept out of high-danger fuel with assured safety of crew, attack at such point. Cut off hot spots and fingers first and then connect pieces of line. This is called "hot spotting."

FIRE IN BUILDING AND SPREADING TO WILDLAND FUELS

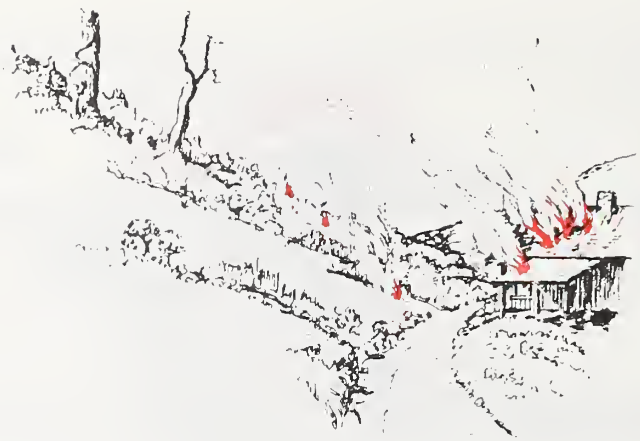


Figure 17.

Condition

Cover and slope are uniform. Fire well established in building and spreading to surrounding wildland fuels.

Action Required

Control wildland fire first selecting key point for attack. Do not waste efforts on building. It is likely you would not save it anyway.

Why

To hold fire and avoid danger of major forest fire, instead of making futile efforts to save the building. In addition, most wildland firefighters do not have the equipment nor training to fight structural fires.

Supplemental Action

Put spot fires out first. Watch for and put out new spot fires. Begin building control line around area and burn out to control spread.

Why

Prevent further spot fires in forest and to prevent escape and spread of fire.

FIREFIGHTERS GUIDE

BUILDINGS AND OTHER IMPROVEMENTS IN PATH OF FIRE

Condition

Slope and fuel are uniform. Fire headed toward toward cabin, fence, or other similar property.

Action Required

First, control key point of wildland fire. Consider improvements as possible key factor in control of fire to prevent them from becoming involved and spreading the fire. Plan and direct efforts to control the fire before it reaches buildings.

Why

To hold fire and avoid danger of a major forest or range fire.

Supplemental Action

If fuel conditions are uniform and not highly hazardous, and high improvement value is at stake, direct efforts to protection of property. Attention must be given to danger of spot fires, not only in the vegetation, but also spotting on the roof of a building.

52.2 - Fireline Location. After the fire and the area ahead of it have been scouted and the key points for attack selected, the next problem is where and how to place the fireline.

1. General Principles of Fireline Location

a. Locate the fireline as close to the fire edge as possible.

b. If the fire is spreading rapidly or is too hot for direct attack, place the fireline far enough back from the fire edge to allow sufficient time for construction and burning out to be completed safely.

c. Make the fireline as short as possible.

d. Capitalize on existing barriers to fire spread in selecting fireline location.

e. When possible put the fireline through open areas to reduce clearing work.

f. Avoid sharp angles in the fireline.

g. Block off high-hazard fuels where possible by leaving them outside the fireline.

h. Locate the fireline far enough from burning snags to enclose them when felled and to catch sparks.

i. Encircle the area where spot fires are so numerous that individual control of them is impracticable.

j. Where a definite topographic feature, such as a ridge, cannot be used for fireline location, oblique lines should be used for frontal attack to pinch off the fire head, rather than a line squarely across the front.

k. Take advantage of the normal daily shift between local up-canyon drafts. Unless general winds counter the effect of local drafts, fires generally burn up canyon during the day, and down canyon at night.

2. Direction of Fireline Construction. It is usually safer to construct a fireline upslope. This minimizes the danger of the fire crossing the slope below the crew and sweeping up to trap them. Downhill construction is especially hazardous in steep terrain and fast-burning fuels, because there is often little time for escape in the event of a flareup.

The decision to construct a fireline downhill should be made by a competent firefighter after complete scouting of the proposed route. When it is done in steep terrain and fast-burning fuel types, the following conditions must always be met:

a. The flank of the fire is anchored at the bottom.

b. The fireline does not run into or adjacent to a chimney or chute which could burn out while crew is in the vicinity.

c. Communications are established between the crew working downhill and the crew working uphill toward them. When neither crew can adequately observe the fire, communications will be established between the crews and a lookout posted where it is possible to see the fire's behavior.

d. The crew will be able to rapidly reach a zone of safety from any point along the proposed fireline if the fire unexpectedly crosses below and sweeps up toward them.

e. Direct attack will be used whenever possible.

f. If direct attack is not possible, the fireline should be completed between anchor points before being fired out. Firing operations should proceed with ensured access into the burned-out part of fireline or other safety zones.

A FIRE BURNING ON A MODERATE-TO-STEEP SLOPE

Figure 1.

Condition

Open timber and scattered groups of reproduction, occasional clumps of reproduction crowning but fire mostly on ground. Greatest rate of spread uphill.

Action Required

Provide escape routes, attacking fire at head. Work down both sides of fire simultaneously, encircling the fire at the bottom. Line should be located at fire edge or parallel to it. As line is built, burn out any fuel between line and fire, regulating the heat of burnout fire so as to minimize crowning. Provide watch for spot fires which may show up much later.

Why

To cut off point of most rapid spread and to minimize spotting.

HOW TO LOCATE LINE TO CONTROL FIRES THAT SPREAD INTO A SERIES OF ELONGATED FINGERS

Figure 2.

Condition

Fire has made fast runs and developed long fingers with unburned areas between. Fire has slowed down.

Action Required

Tie ends of fingers together with shortest possible control line and burn out promptly between this line and burn area.

Why

Control fire with a reasonable expenditure of effort. The reduced length of control line will be easier to hold.

Supplemental Action

1. Same problem exists when too many spot fires develop in limited area to control individually. Encircle them inside fireline and burn out.

2. If values such as plantation or areas of natural reproduction justify the additional expenditure, and weather conditions permit (high humidity), line may be located at the fire edge and fingers mopped up.

HOW TO LOCATE LINE TO CONTROL LOWER FLANK OF FIRE ON STEEP GROUND

Figure 3.

Condition

Cover brush or timber. Spread medium. Ravine dry. Side slopes steep. Wind has driven fire diagonally up slope.

Action Required

Locate line on opposite side of draw from rear of fire; proceed along ravine until rolling material from head of fire cannot cross rear line; locate line up flank, converging on head of fire.

Why

To prevent burning material from rolling over control line.

Supplemental Action

Keep line as near the bottom of the draw as possible. Control rate of burning out to reduce volume of heat.

HOW TO CONTROL HEAD OF FIRE BURNING ON SLOPE AND NEARING SHARP CREST OF RIDGE

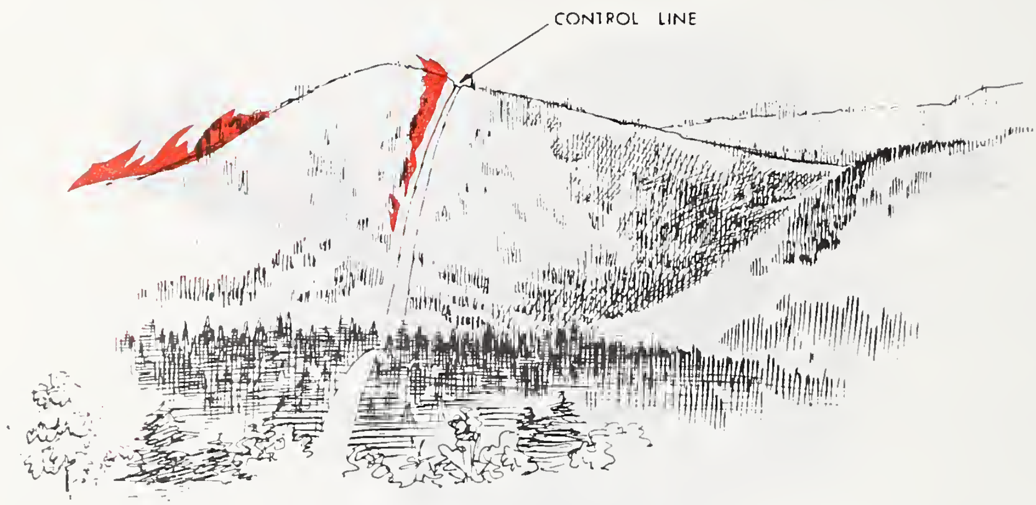


Figure 4.

Condition

Fire running uphill rapidly in moderately dense brush or reproduction.

Action Required

Drop just over crest of ridge away from slope on which fire is running, and build line. Trench if necessary to prevent rolling material from getting over. Burn out to a blackline promptly after construction.

Why

To provide a wide line when fire reaches crest; to prevent main fire from sweeping over control line; to permit clean burning of line with initial uphill run of burn out fire; take advantage of counterdraft that will slow up main fire and cause sparks to fall back in burned area.

HOW TO LOCATE CONTROL LINE WHEN FUEL TYPE OUTSIDE FIRE CHANGES MARKEDLY

Figure 5.

Condition

Fire established in mature mixed-timber type. Spread moderate. Wind direction steady. Dense fuel with many snags and down logs some distance ahead of fire. Direct attack on fire impossible or dangerous.

Action Required

Locate line in timber, far enough from edge of snag patch, to prevent spotting into snag area. Locate as close to fire edge as possible, leaving time to complete and burn out line.

Why

Resistance to control in snag area greater than in green timber. Key action is to confine fire to green timber.

Supplemental Action

Solution is same where fire threatens to move from any fuel type with low resistance to control, to any type with greater resistance to control. For example, a fire moving from grass toward brush or from open mature timber toward dense reproduction should be kept out of the reproduction if possible.

HOW TO LOCATE LINE WITH REFERENCE TO BURNING SNAGS INSIDE FIRE

Figure 6.

Condition

Topography level. Wind light. Rate of spread moderate. Snags burning too hot to cut down.

Action Required

Locate line far enough from fire to catch glowing sparks and embers coming from burning snags, and to enclose snags themselves when they fall or are cut. Maintain constant watch for spot fires. Burn out line as constructed.

Why

To prevent loss of line caused by embers blowing into unburned area, or by snags falling.

HOW HEAT OF FIRE AFFECTS DISTANCE OF CONTROL LINE FROM THE EDGE

Figure 7.

Condition A

A small fire is established in part of a large area of slash and threatens the entire area. There is a road near the flank and skid trails near the head of the fire. These may slow down the fire, but will not stop the fire. Fire can be held at the skid trail if effort of workers is concentrated at the head. Heat is uncomfortable, but not unbearable for a few minutes at a time.

Action Required

Make every effort to stop fire at road and skid trails. Use dirt and water to cool down fire at edge of skid trail. Use individual workers short periods on line; alternate with other workers.

Why

Facing hot fire is necessary to prevent fire from crossing skid trail and creating major fire involving whole slash area. Ways of escape are open. Utilizes existing barrier.

Supplemental Action

Similar action may be necessary to keep hot fire (a) from getting into any heavy fuels where line construction may become much more difficult or, (b) from burning any structures that might be in the path of the fire.

Condition B

Fire established in large, dense brushfield, full of down logs. No barrier near fire edge. Night time. Rate of spread slow, but volume of heat great.

Action Required

Locate line beyond zone of intense heat, but close enough to minimize length of line. Burn out unburned fuels inside line.

Why

Nothing to be gained by making work needlessly uncomfortable by working too close to fire edge.

Supplemental Action

Same problem with any slow spreading, but very hot fire, where key to solution is sureness rather than speed of control.

HOW TO LOCATE LINES WITH REFERENCE TO NATURAL
OR MANMADE BARRIERS

Figure 8.

Condition

Fire burning just above canyon in steep country. On one spur extending to canyon is a trail leading from the main ridge which parallels canyon; along this ridge is a series of large rock outcrops making a barrier which will at least temporarily stop main head of fire.

Action Required

Utilize the trail as a control line on the one side and tie the bluffs together at top with a control line. Locate necessary control line from natural rock outcrop to canyon bottom barrier. Burn out unburned fuels between control line and fire.

Why

Use of existing natural or manmade barriers as parts of control line expedites control of a fire by reducing size of job. Trails, roads, streams, barren areas, and firebreaks usually make easier and safer lines to patrol.

HOW TO LOCATE LINES TO CONTROL NARROW HEAD OF FIRE,
TOO HOT FOR DIRECT FRONTAL ATTACK

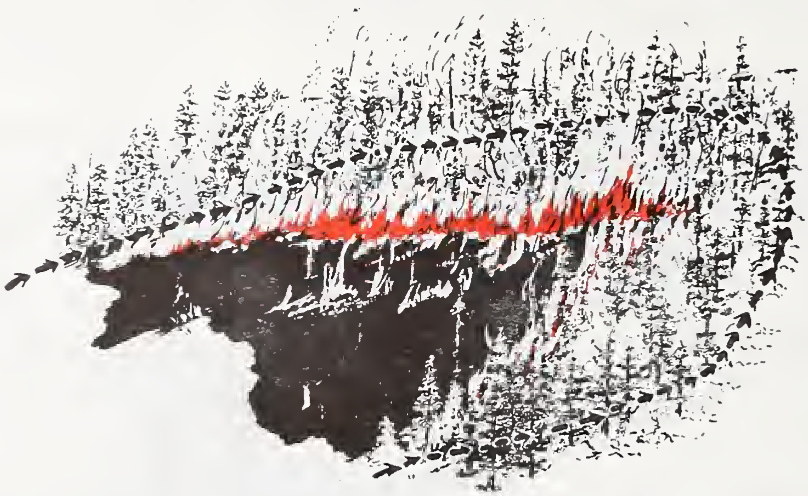


Figure 9.

Condition

Rapid rate of spread up steep slope; uniform fuel; mature timber; many young trees.

Action Required

Locate fireline safely away from fire, allowing enough distance and time to safely construct lines by flanking attack, starting from anchor points and working around head of fire, avoiding sharp angles. Burn out unburned fuels between control line and fire. Watch head of fire so that it does not cross line or endanger workers.

Why

When there is a sharp bend in a line around head of a hot fire, danger of spotting is increased greatly since the intensity of fire is concentrated at a point instead of being distributed along a wider front. Wind from any one of three directions will tend to blow the fire over some portion of the line in vicinity of the sharp angle.

Supplemental Action

Line location along trails, roads, ridges, or streams with sharp angles should likewise be avoided.

52.3 - How Fires Can Cross Fireline. Fire can cross a fireline in many ways.

1. Flames or heat reach across the line and ignite outside fuels. (This is important in determining width of line.)

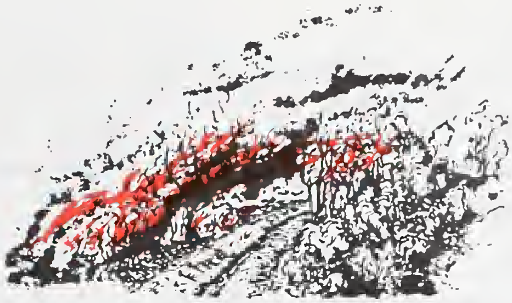


Figure 1.

2. Sparks and embers cross the line. Sparks are blown across the line by the wind or are carried by air currents. (Usually not important in determining line width.)

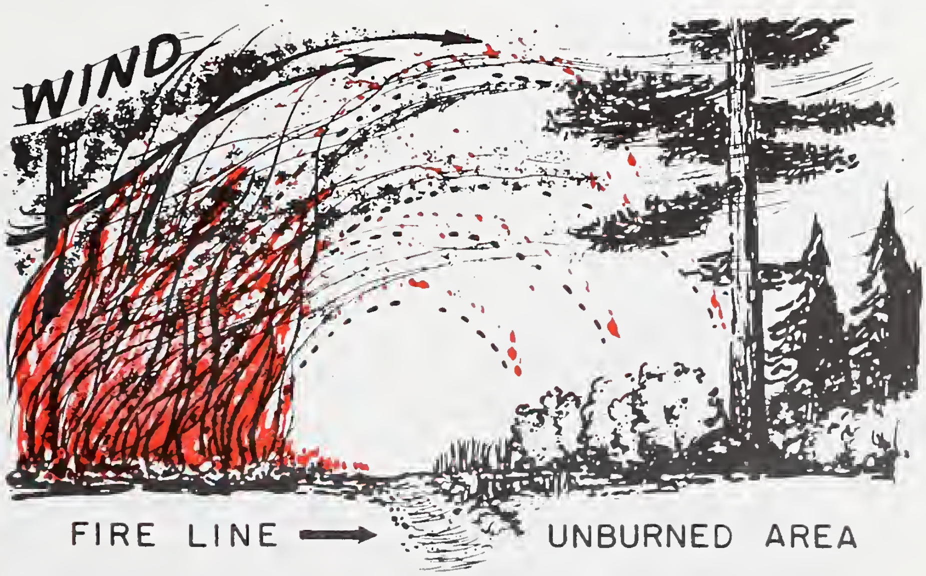


Figure 2.

Sparks are carried across the line by gravity--by burning material rolling, sliding, or falling. (This is important in determining the depth of line and amount of trenching.)

PREVENTION OF CROWN FLARE-UPS

Condition

Surface fire beneath or near trees with branches extending nearly to the ground.

Action Required

Cool down surface fire aggressively and extinguish it completely as soon as possible. Avoid stirring up sparks that can be carried into tree crowns. Prune lower branches from trees and remove from fire area. Especially aggressive action is necessary where branches are draped with moss.

Why

Keeping fire from spreading into tree crowns prevents spotfires that would be started by drifting embers from the crowns.

Supplemental Action

This situation commonly occurs where fuels on the ground are slow-burning and/or sparse. In such situations keeping the fire out of the crowns often is more urgent than getting a line around the fire.

Figure 3.

Low hanging branches, and other fuels near line cause trouble.

Figure 4.

Remove low hanging branches, smaller trees and other fuels near line.

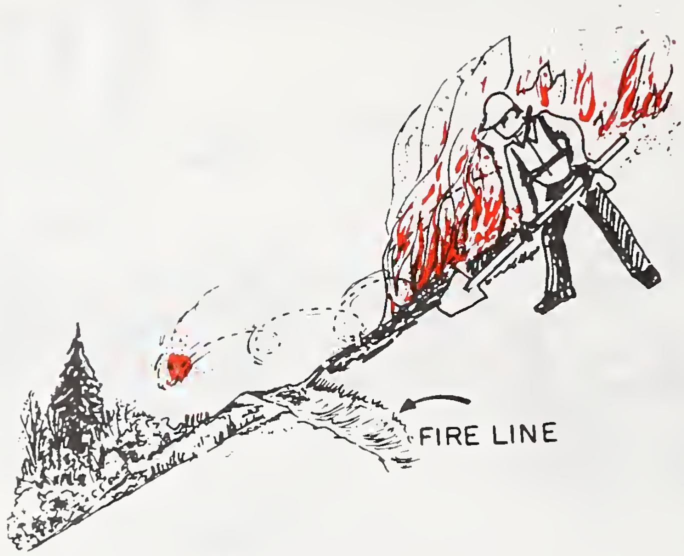


Figure 5.

Figure 6.

Sparks or embers are rolled, thrown, dragged, or flipped across line by workers, either carelessly or accidentally.

Figure 7.

3. Fire may creep across fireline through duff, peat or roots. (Depth of line is important.)

Figure 8.

4. Heat or flame may reach upward and ignite overhead fuels. (Overhead clearing above the line is important.)

Heat can ignite fuels across or above the fireline even if flames do not reach the fuels. Radiation or convection of heat may ignite fuels on the opposite side of fireline which is too narrow or has too little overhead clearance.

a. Radiation. Radiation is transmission of heat through the air by rays. The heat may be radiated in all directions, horizontally as well as vertically (similar to heat radiated from a stove). Fuels too close to intense heat can be ignited even if not touched by flame.

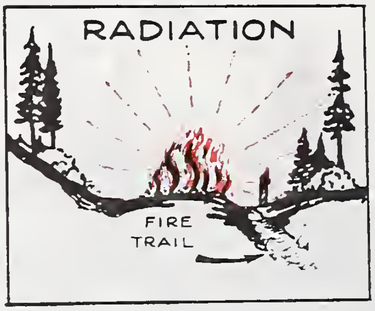


Figure 9.

b. Convection. Convection is transmission of heat by currents of air. Convection currents preheat the fuels ahead of a fire (across the fireline or above the fireline) and make them easier to ignite.

If too close, fuels can actually be ignited by convection currents.

Figure 10.

52.4 - Fireline Construction. Anything that affects how a fire burns must be considered in deciding the width of line needed to hold or control the fire. The hotter or faster the fire burns, the wider the control line must be. Six important factors in determining line width are: fuel, slope, weather, part of fire, size of fire, and possibility of cooling.

FIREFIGHTERS GUIDE

1. Fuel.

a. Kind of fuel. Some fuels burn hotter than others because they contain large amounts of inflammable oils. Greasewood (chamise), pines, palmetto-gallberry, and junipers are examples of oily, hot-burning fuels. The hotter the fuel burns, the wider the control line must be.

b. Height and density of fuels. Ground fuels--heavy or light. Overhead fuels--dense or open.

Generally, the higher and denser the fuel, the higher and hotter the flame will burn and the wider the control line must be.

c. Size of fuels. As a general rule, the heavy fuels, such as sound logs (not punky logs), heavy limbs, and thick-stemmed brush, do not ignite as easily and fires do not spread as fast as in the finer, lighter, and flashier fuels, such as grass, leaves, needles, and twigs. However, once they are ignited, logs, snags, and heavy branches burn very hot for a long time and may require wide control lines to keep the flame, sparks or radiated heat from igniting fuels across line.

d. Condition of fuel. The condition of fuel, whether it is dead or alive and, if alive, whether it is succulent, green, curing, or dry has a definite effect on the burning rate or intensity of the flame. Generally, the drier the fuel the hotter it burns, and the wider the line must be; the greener or more succulent it is, the less intensely it burns, the narrower the line can be.

2. Slope or Topography. The slope where a fire is burning may vary from level to moderate or steep.

When a fireline is built above a fire burning on a slope, generally the steeper the slope the wider the line must be because the fire usually burns faster and more intensely; the more gentle the slope the narrower the line can be.

When a fireline is built below a fire burning on a slope, the width of the line necessary does not depend so much on the slope, but trenching becomes important. Generally, the steeper the slope, the deeper the trench must be, to prevent rolling burning material from crossing the fireline.

3. Weather Conditions. The weather conditions are temperature, humidity, fuel moisture, air currents or wind--drafts created by fire (convection currents), local wind.

In general, the higher the temperature the lower the humidity; the lower the fuel moisture or the stronger the wind (air currents), the more intensely a fire will burn and the wider the fireline needed.

The wind or air currents increase the burning intensity by supplying more oxygen, by moving currents of hot, drying air into the fuels ahead, or by actually carrying burning embers ahead of the fire itself. Therefore, the stronger the wind or convection current, the wider the line must be.

4. Part of Fire to be Controlled. The parts of the fire to be controlled are: the head; the flank; and the rear (figure 1).

Generally, a fire burns hottest and with largest flames at the head, not as hot on the flanks, and with the least heat at the rear. Line width must, therefore, generally be widest at the head, may be narrower on the flanks, and may be narrowest at the rear.

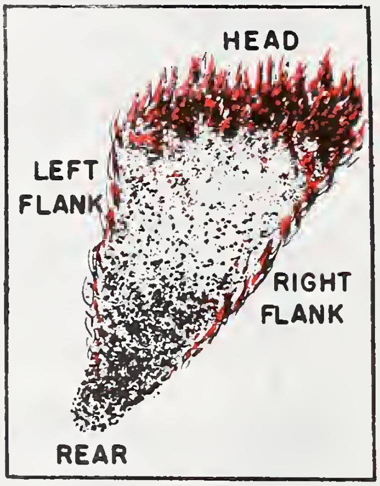


Figure 1.
Parts of a fire.

5. Size of Fire being Controlled. The amount of heat produced by the fire has a definite bearing on the width of line necessary to control the fire. A large fire is generally burning hotter than a small fire in the same type of fuel, therefore the large fire may require a wider control line than the small fire.

6. Possibility of Cooling Fire.

a. With dirt.

b. With water.

When plenty of water or dirt is available, generally a narrower line can be built because the flames can be cooled with water or dirt.

7. Minimum Requirements for Line Width and Line Depth

a. Clearing. Brush, trees, and logs must be removed from a strip only wide enough to build the fireline, to permit safe working and to allow access when fire is hot.

Figure 2.--Cleared width kept to a minimum.

b. Scraping. All flammable material must be removed to mineral soil from a strip wide enough to prevent fuel from being ignited by heat or flame when burning out from the fireline. (Duff burns with very little heat radiation, so only a narrow scraped strip through duff is necessary.) Scraped strip will be placed on outside of cleared line.

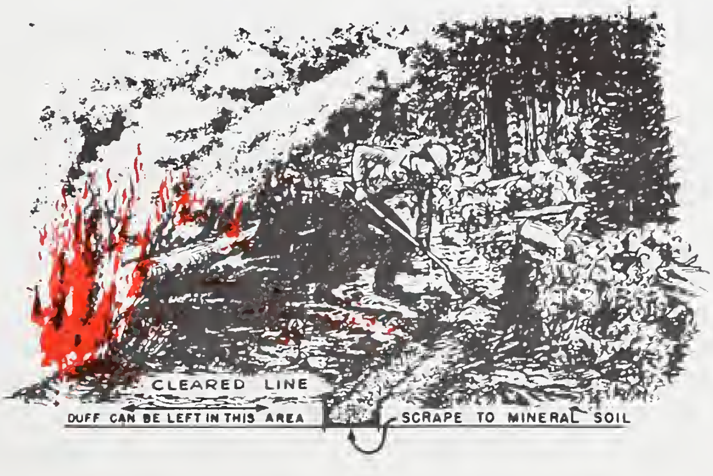


Figure 3. Properly scraped and cleared fireline.

8. Approximate Line Widths Under Specific Sample Conditions. The width of line will be governed by a combination of two or more of these factors--fuel (kind, height, density, size, and condition), slope, weather condition (temperature, humidity, fuel moisture, and wind), part of fire being controlled, size of fire being controlled, and possibility of cooling the fire.

Certain conditions or factors are specifically mentioned in each of the following examples. Only those mentioned are to be considered in determining the line width. Other factors or conditions are assumed to be average and are not to be considered in the solution of the specific problem.

a. Flank of fire burning in pine needles

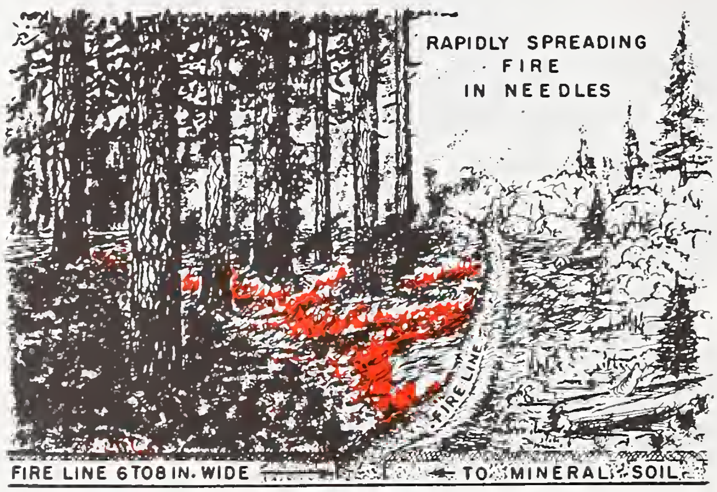


Figure 4.--Flank of fire burning in pine needles.

Condition

Flank of fire spreading rapidly through an average or medium cover of pine needles.

Line width necessary

A narrow fireline 6 inches to 8 inches wide, scraped to mineral soil is generally sufficient on the flank. Flames are not high and heat not great in pine needles, so a wider line is generally not necessary to stop the fire or hold the burning-out fire. The line must be scraped to mineral soil to prevent smoldering across the line.

b. Flank of fire in brush cover

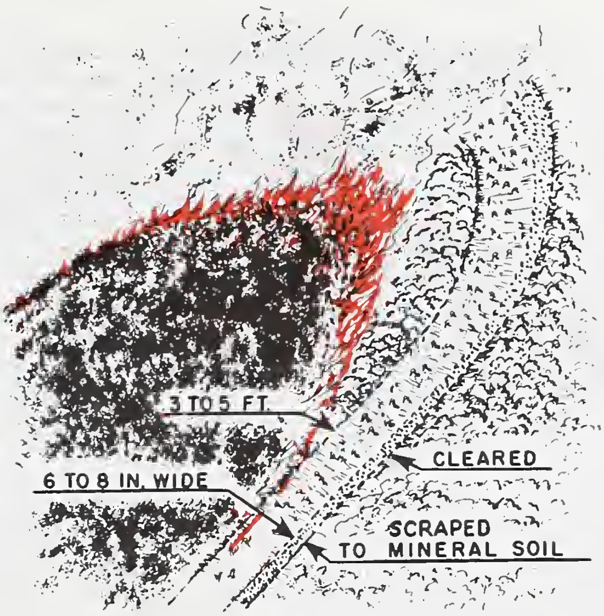


Figure 5.--Flank of fire in brush cover.

Condition

Flank of a slowly spreading fire in brush cover of average density and 3 to 5 feet high; flat ground.

Line width necessary

Brush burns with a higher flame than fire in pine needles and requires wider line clearance. A clearing at least as wide as the brush is high should generally be sufficient on the flank of a fire. If the brush were very dense and tall so that it burned very hot, it might be necessary to cut a wider line even on the flank of the fire. To prevent smoldering through the duff on the ground, it is necessary to scrape a 6- to 8-inch width on the outside of the cleared strip. (This compares with the 6- to 8-inch scraped width in pine needles.)

c. Head of fire in brush cover--fire burning with wind

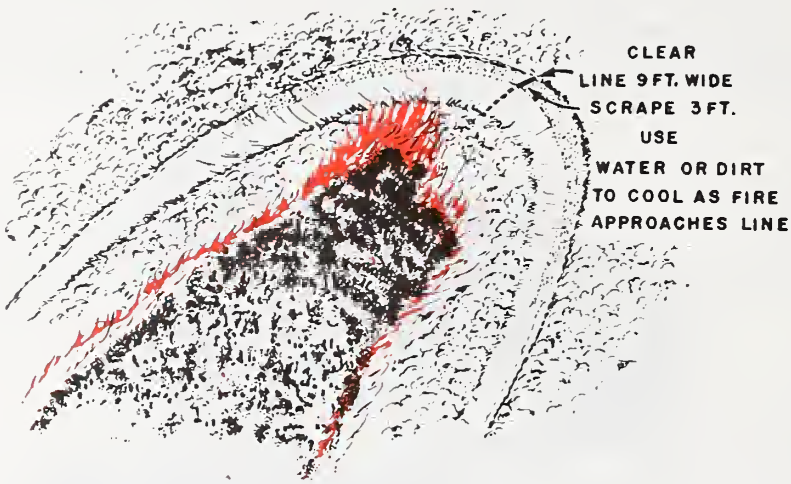


Figure 6.--Head of fire in brush cover--fire burning with wind.

Condition

Same as b. except head of fire and gentle wind (8 to 12 m.p.h.)

Line width necessary

Head of brush fire with gentle wind blowing requires a wider line than under conditions of b. For these conditions a cleared width should be at least twice as wide as the brush is high, but dirt or water would have to be used to cool fire as it approached the line. Denser or higher brush might require an even wider line. To prevent smoldering across the line through duff, it is necessary to scrape the outer 3 feet of the cleared width because of the intense heat of the brush fire.

9. Principles of Fireline Construction

a. Make line no wider than necessary.

b. Clean all lines to mineral soil for all or part of width.

c. Scatter charred or burning material from line construction inside the burned area.

d. Unburned material from line construction: scatter whichever way is easiest and faster, provided this does not increase burning and heat at line and make line too hard to hold or complicate mopup; if fuel is needed for burning out, place inside the line.

e. Protect undercut lines against rolling material.

f. Effectiveness of a given width of line can be increased by using dirt or water to cool down adjacent fire.

g. Rotten logs or stumps just outside the line should be covered with dirt or wet down if water is available.

HOW TO DISPOSE OF MATERIAL REMOVED IN LINE CONSTRUCTION

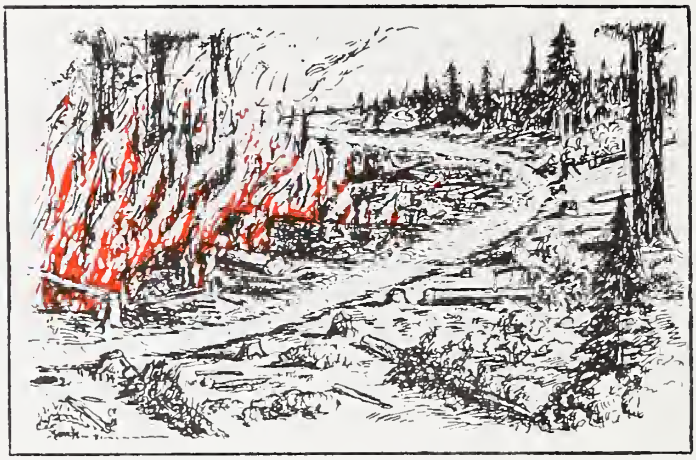


Figure 7.

Condition A

Work can be done directly on the fire edge because it is spreading slowly.

Action Required

Burning or charred material should be scraped into the unburned area. Unburned material should be put on the outside of the line. The charred or burning fuel should be well scattered in the burn.

Condition B

Line must be constructed some distance away from the edge of the fire.

Action Required

If the removed cover is light, it should be thrown whichever way will make for most rapid line construction, care being taken not to build up heavy piles of fuel inside and close to the line. If the fuel is needed for burning out, it should be placed inside the line.

Why

To avoid building up the supply of fuel close to line with consequent increased danger of the fire getting across; to dispose of material in easiest way.

HOW TO USE RELATIVELY NARROW LINE TO SPEED CONTROL

Figure 8.

Condition

Sometimes a line narrower than desirable can be constructed quickly through trees and reproduction seedlings in order to speed-up control. However, these must be burned out or fire will spread to them. There will be considerable danger of spotting or flaring over line and the line must be watched closely.

Action Required

Throw dirt or use water to keep fire out of tree crowns immediately adjacent to line.

Why

To speed up containment and control, reduce intensity of burning and to minimize danger of spotting or crowning over line.

Supplemental Action

Same problem if fire is burning in brush.

PROTECTING MOST FLAMMABLE FUEL OUTSIDE FIRELINE

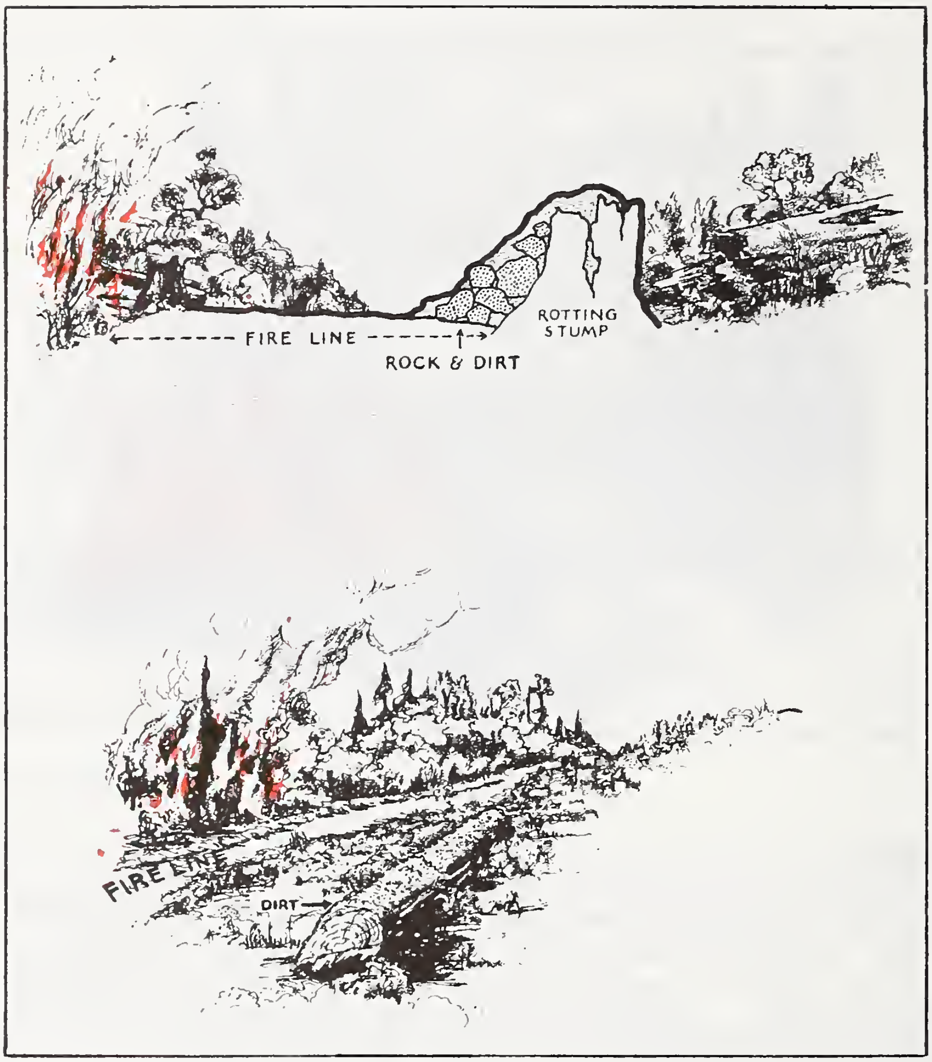


Figure 9.

Condition

Fire close to rotten stumps or logs which are outside of line and not burning.

Action Required

Cover stump and logs with dirt or wet down with water if available.

Why

Dry, rotten logs and stumps are easy places for sparks or embers to start new fires.

HOW TO TRENCH BELOW A FIRE ON A SLOPE

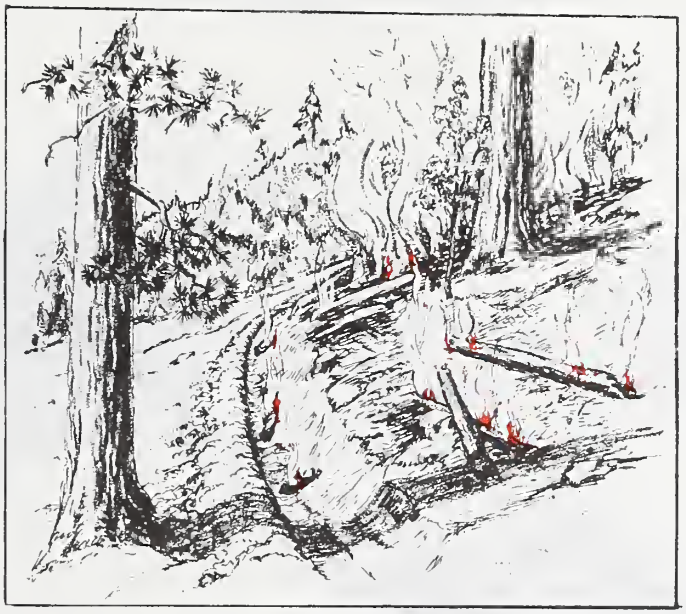


Figure 10.

Condition

Fire backing down moderate slope in needles. Cones, scattered wood fragments, and other materials may roll readily. Trenched line is needed to catch material. Dirt available.

Action Required

Convert fireline into a trench by excavating clean mineral soil and piling along lower edge.

Why

To catch hot rolling material which may spread fire across line.

Supplemental Action

Logs should be moved to lie up and down slope, or blocked to prevent rolling; this reduces the amount of trenching necessary.

HOW TO BUILD TRENCH TO HANDLE ROLLING MATERIAL IN ROCKY COUNTRY

Figure 11.

Condition

Fire on steep rocky slope, with material that will roll when disturbed by fire.

Action Required

Convert fireline into trench as in previous problem, using stones, small logs, or other debris to form foundation of berm. Cover face with mineral earth. If necessary, use trees, stakes, or stones to hold logs in place.

Why

To build effective barrier against rolling material, and to do it faster than is possible with dirt alone.

EFFECTIVE USE OF FIREBREAK

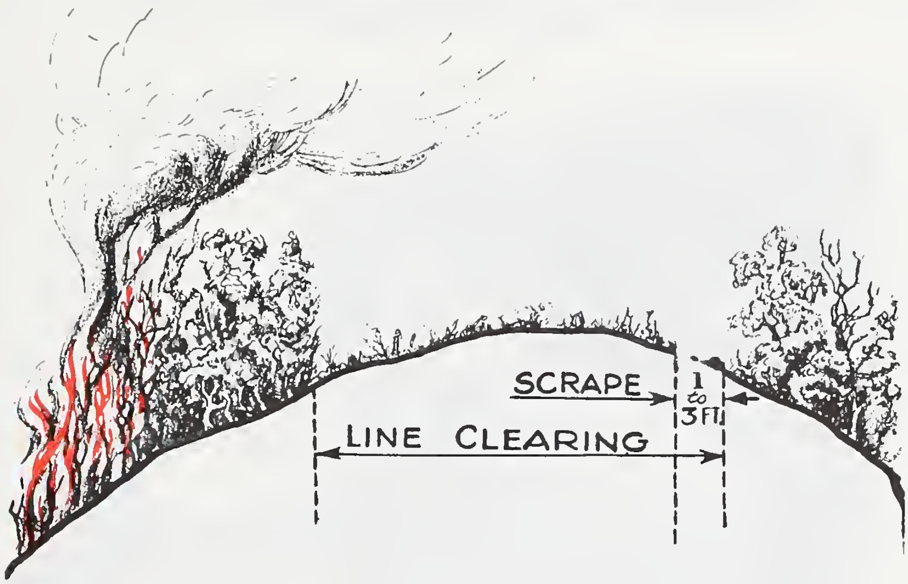


Figure 12.

Condition

Firebreak is to be burned out. Light cover of grass and weeds on break.

Action Required

Before burning out, clear fuel from break on strip 1 to 3 feet wide on edge of break away from fire.

Why

To obtain full effectiveness of entire width of break.

Supplemental Action

Same principle applies when constructing control line in heavy brush or reproduction.

HOTSPOTTING--USING TEMPORARY LINES TO CHECK FIRE AND GAIN TIME

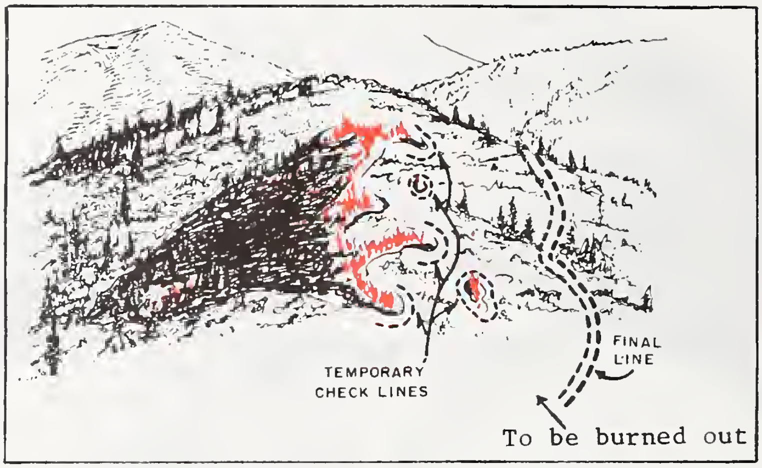


Figure 13.

Condition A

Fire has run up steep heavy brush slope and has slopped over crest in stringers and spots too ragged and numerous to control by direct attack. Time needed to complete line.

Action Required

Put a temporary checkline around the threatening stringers and spot fires to hold them in check while constructing fireline.

Why

To gain time for location and construction of final line.

Condition B

Fire in pine needles, leaves, duff, or grass. Forces available are insufficient to construct final control line at once.

Action Required

Put in temporary lines. Then, strengthen line or build new or final line.

HOW TO KEEP FIRE OUT OF SNAGS THAT ARE LEFT INSIDE THE CONTROL LINE

Figure 14.

Condition

Fireline could not be located to prevent leaving some snags inside the fireline. Some of the snags are close to the line, but are not burning. Danger of spotting is great if snags catch fire. Time insufficient to fell snags.

Action Required

Build lines around individual snags or groups of snags and remove all fuel from base of snags. This is called ringing a snag.

Why

To prevent snags from catching fire and throwing sparks outside of fireline and starting spot fires.

52.41 - Backfiring/Burning out. See Glossary for definition of these terms and their relation to fire suppression.

52.5 - Mopup. After primary line construction work is completed and a fire is called "controlled," many things remain to be done to make the fireline "safe" and put the fire out. This work is called mopup. The objective of mopup is to put out all fire embers or sparks to prevent them from crossing the fireline.

A certain amount of mopup work is done along with line building. Mopup becomes an independent part of firefighting as soon as the spread of the fire is stopped and all line has been completed. Ordinarily, mopup is composed of two actions; putting the fire out, and disposing of fuel either by burning to eliminate it, or removing the fuel so it cannot burn.

The principles of mopup follow:

1. Start work on each position of line just as soon as possible after line construction and burning out are completed. Treat most threatening situations first.

2. Allow fuel to burn up if it will do so promptly and safely.

3. On small fires, all fire should be extinguished in the mopup, where quantities of burning material are not so large as to make this obviously impracticable.

4. On large fires, completely mop up enough of the area adjacent to the line to be certain no fire can blow, spot, or roll over the fireline under the worst possible conditions.

5. Search for smoldering spot fires.

6. All smoldering material that is not put out with water or dirt should be spread well inside of lines.

7. Eliminate or put into safe condition all fuel of great inflammability, such as rotten logs and snags, that is outside but near the control line.

8. Look for and dig out burning roots near control lines.

9. Separate masses of large fuel to reduce heat and danger of spotting.

10. Eliminate all snags inside of line that could, under most adverse weather conditions, throw sparks over line or fall over the line.

11. Put all rolling material into such a position it cannot possibly roll across the line.

12. Dig trenches immediately below all heavy material which might roll across the line.

13. Look for indications of hot spots. Some are gnats swarming, white ash, ground which shows pin holes, and wood boring insects. Feel with hands for possible smoldering spots. (Use caution to prevent burning of hands and fingers.)

14. Use water wherever possible and practical in mopup.

15. Use water sparingly, but use enough to do the job. Match the amount of water to the job.

16. When using water to mop up deep-burning fuels such as peat, duff or needles, scrape or stir the fuel while applying water.

17. Adding wetting agents to water will greatly increase effectiveness in mopup of deep-burning fuels.

18. Portable infrared devices may be available to assist in locating "hot spots." If so, use with trained operator.

19. Cut out partially-burned clumps of brush or reproduction close to fireline.

HOW TO TREAT BURNING LOGS TOO LARGE TO MOVE

Figure 1.

Condition

Large, burning log lying in a bed of hot coals and ashes.

Action Required

Remove hot coals and ashes from beneath log. Work from cool edge to avoid burning feet. Cool down with dirt or water; cover hot ground with cool earth; alternate use of water or dirt and scraping until log is out. If power saw and operator are available cut log to separate burning and unburned sections.

Why

Remove source of heat which keeps log burning.

Safety

People working on logs on slopes must be alert to the possibility of the log turning or rolling. Block the log with rocks to prevent it from rolling.

Supplemental Action

This principle applies to all mopup work: Remove source of heat.

HOW TO DISPOSE OF BURNING MATERIAL NEAR FIRELINE

Figure 2.

Condition A

Light fuel types where burning material can be readily moved.

Action Required

Scatter fuel well back from line into burned area and allow it to burn.

Why

To decrease possibility of fire spotting or blowing over line.

Condition B

Heavy fuel types with many stumps and logs too large to move. Wind blowing sparks over line.

Action Required

Cool down heavy burning material with dirt or water. Then proceed with complete mopup of individual logs and stumps as soon as cool enough to work.

Why

Reduce danger of spotting across line. Smother fire and reduce heat to allow for complete mopup of heavy materials.

Supplemental Action

Burning material must not be left buried. It should be uncovered later and completely extinguished to make it safe.

HOW TO DISPOSE OF HIGHLY HAZARDOUS FUELS OUTSIDE OF BUT ADJACENT TO FIRELINE

Figure 3.

Condition

Punky limbs and masses of slash just outside of hot fireline.

Action Required

Remove fuels to a safe distance from fireline. If removal is impracticable, graves should be dug and the fuels rolled into them and covered with a layer of clean earth. This is safer than attempting to cover them by building up a mound of earth.

Why

To remove fuels likely to act as hosts to spot-fire.

DISPOSAL OF BURNING SNAGS

Figure 4.

Condition A

Snag burning inside and near line with fire above reach of firefighter.

Action Required

Scrape away all hot material from base. Cover hot ground with cool dirt or cool with water. Fell snag away from line into burn, up and down hill if lean permits. Scrape all burning material from felled snag and extinguish with dirt or water.

Safety

Post a lookout to give fallers warning of falling tops or limbs. Plan and clean an escape route and go through a practice escape or "dry run."

Condition B

Snags burning in base only.

Action Required

Scrape away hot coals and ashes and cover hot ground with cool dirt. Knock down blaze with dirt or water; chop or scrape out burning portion with ax or shovel; peel off loose bark as high as can be reached; apply dirt or water to cracks to extinguish any sparks which might be smoldering; scatter the material removed from snag in burned-over area. Put out with water or dirt.

Why

By removing heat from base of snag, cooling will start immediately. Snag will be safer to fell and sparks will be reduced. People can work without burning feet.

Supplemental Action

If lean of snag does not permit falling into burn, a space must be cleared outside of burn where the snag will fall.

HOW TO PREVENT FIRE FROM CREEPING THROUGH DEAD ROOTS UNDER FIRELINE

Figure 5.

Condition

Dead roots burning inside of and extending under fireline.

Action Required

Uncover and remove burning portions of root. Dig out and cut off roots under fireline.

Why

To prevent fire burning underground and coming up in unburned areas.

HOW TO HANDLE LOG PILES BURNING NEAR FIRELINE

Figure 6.

Condition

Burning logs within spotting distance of line.

Action Required

If logs are movable, separate and move them to lie up and down slope; trench where necessary. Scrape off coals and use dirt alternately to put them out. Use caution when moving logs to avoid injury. Stay on uphill side.

Why

To reduce heat and thereby decrease possibility of spotting. To prevent rolling embers when slopes are steep.

Supplemental Action

If logs will not spot over line or cannot roll, leave them in piles and burn them up. This eliminates the hazard and reduces the mopup job.

HOW TO PLACE MOVABLE, BURNING LOG SO IT WILL NOT ROLL

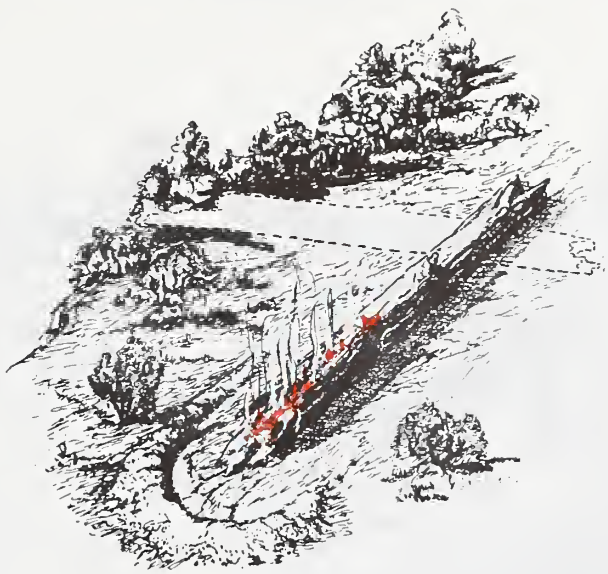


Figure 7.

Condition

Burning log lying on contour of slope.

Action Required

Move log to lie up and down slope. Trench around lower end to catch rolling embers. (Caution: Work only from uphill side while moving log.)

Why

To prevent logs and live embers rolling into unburned territory.

Supplemental Action

If log is too large to handle, cut to sizes that can be moved and proceed as above. If log is too hot or to large to cut, block with rock or earth and trench along lower side of log to catch rolling embers and the log. Alternate use of dirt and scraping and/or water to put fire out.

HOW TO HANDLE BURNING STUMPS

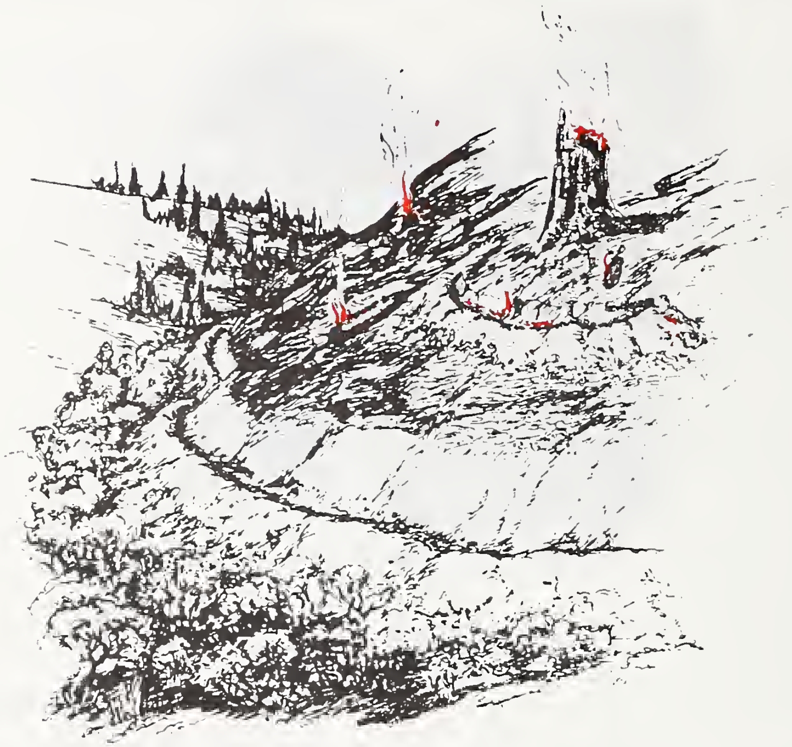


Figure 8.

Condition

A fire on a steep slope has burning stumps that should be allowed to burn up, but which may result in live embers rolling over the undercut fireline on the lower edge of the fire.

Action Required

Construct a trench close to and on the downhill side of the stump, to catch the burning embers.

Why

To prevent burning embers from rolling and possibly going over trenched fireline. Placing the trench close to the stump makes it more effective.

HOW TO DISPOSE OF BURNING CHUNKS, LIMBS, AND SMALL LOGS

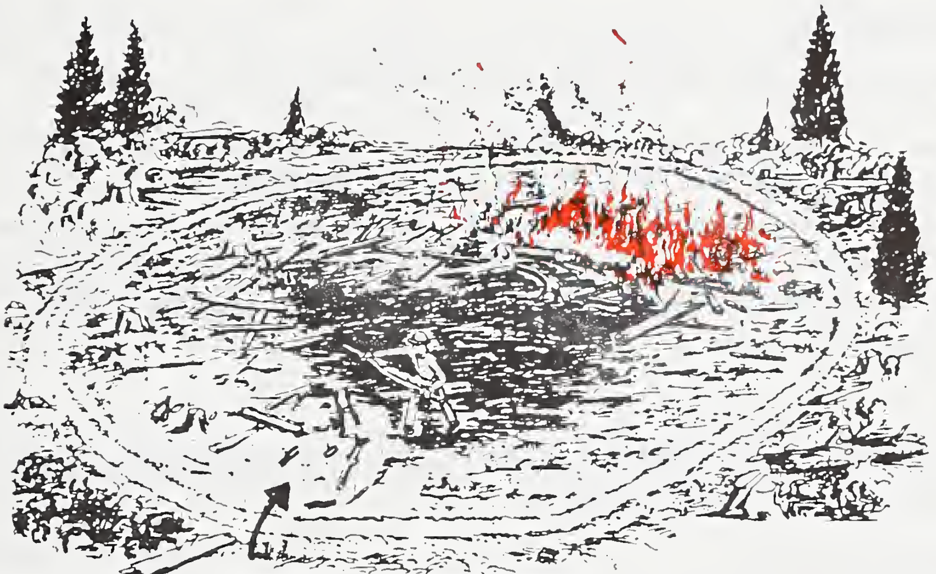


Figure 9.

Condition A

Many burning chunks, limbs, and small logs on moderate or steep slope; may roll over trenched line.

Action Required

Construct trenches along slope in burn long enough to hold all chunks. Place chunks in trenches. Let them burn up.

Why

To allow chunks to burn out without danger of rolling over lower fireline.

Condition B--Boneyarding

Small fire in cut over timber. Many limbs, chunks, and small logs; not all burning.

Action Required

Systematically work the entire fire area using dirt to cool. Scrape off hot coals. Pick up the limbs and feel with hands. If material is out, pile in burned area in a spot cleared of all burning or hot fuels. This is called "boneyarding."

Why

Results in thorough mopup with little chance of material again catching fire.

Safety

Feel carefully. Use back of hand close to but not touching wood to test limbs which may be hot.

Supplemental Action

Same system may be used to mop up area adjacent to line on a larger fire.

HOW TO USE THE HANDS IN MOPUP

Condition

A severe fire has burned over a small area that contained a fairly heavy stand of timber with duff, a few patches of brush, and some rotten logs. The fire appears to be out and no smoke can be seen.

Action Required

Test the burned area with bare hands; feel particularly in partly consumed duff, in incompletely burned litter, and into the remains of punky logs. Dig out hotspots as discovered, and extinguish with dirt or water. Place hand close to material first, then cautiously touch if heat is not felt.

Why

To locate smoldering fire which cannot be seen. Prevent rekindling of partially burned material.

Safety Precaution

Feel slowly and carefully for hot material. Use back of hand to test above piles of white ashes. Back of hand is more sensitive to heat. Severe burns may result from lack of caution in "feeling out."

HOW TO USE WATER EFFECTIVELY IN MOPUP

Condition

Fire has burned up steep slope with vertical rise of 1,000 feet; truck trail on crest of ridge; lower fireline parallels a small stream. An engine, backpack outfits, portable pump, and hose available. Unsafe to leave fuels to burn up.

Action Required

Assign crew to mopup bottom portion of fire with portable pump near stream. Engine crew operates from truck trail and works down from top. Backpack crew works in area not covered by portable pump and engine. Handtool people working with nozzle operators enter and go over area methodically, turning all chunks and small logs, and applying water with spray. Also stir or spade and turn all duff while spray is applied. This procedure should be repeated until all fire is extinguished. Mopup effectiveness can be increased by using wetting agents.

If accumulations of heavy fuels are burning close to control line, they should be cooled down first to reduce danger of loss of line.

Why

If properly and skillfully applied, water will greatly speed up the job of mopup. Water can reduce duration and cost of patrol and relieve firefighters for other fire duty.

Supplemental Action

Small fires can best be suppressed by applying this principle to the whole area (rather than just around the perimeter as stated for a large fire). Water alone cannot do the job. To be effective, handtool work turning hot material to let the water get to the fire is necessary. Drowned fires should be checked repeatedly for sparks which have been overlooked in the mopped-up area.

HOW TO MAKE SAFE PARTIALLY-BURNED CLUMPS OF BRUSH OR REPRODUCTION CLOSE TO THE FIRELINE

Condition

A fire ran through brush or reproduction close to the line, but has merely dried it out without consuming the crowns.

Action Required

To eliminate the threat of reburn.

1. If the amount is not too large, cut down and scatter away from the control line inside the burn in areas free from fire.

2. If no danger of spotting across line, use special firing equipment such as torches and flame throwers, to burn out scorched crowns.

3. If the patches are too large to handle by methods 1 or 2, put out all surface fire within them and construct a good line between them and the rest of the fire.

Why

To either remove fuel or isolate from possible ignition next day. Scorched crowns of brush or reproduction are particularly dangerous fuels. They ignite readily during heat of day and fire will flash through the crowns over previously burned ground. The danger of spotting and flaring over adjacent lines is extreme.

LINE AROUND FIRE, BUT UNBURNED MATERIAL BETWEEN
LINE AND RAGGED EDGE OF FIRE

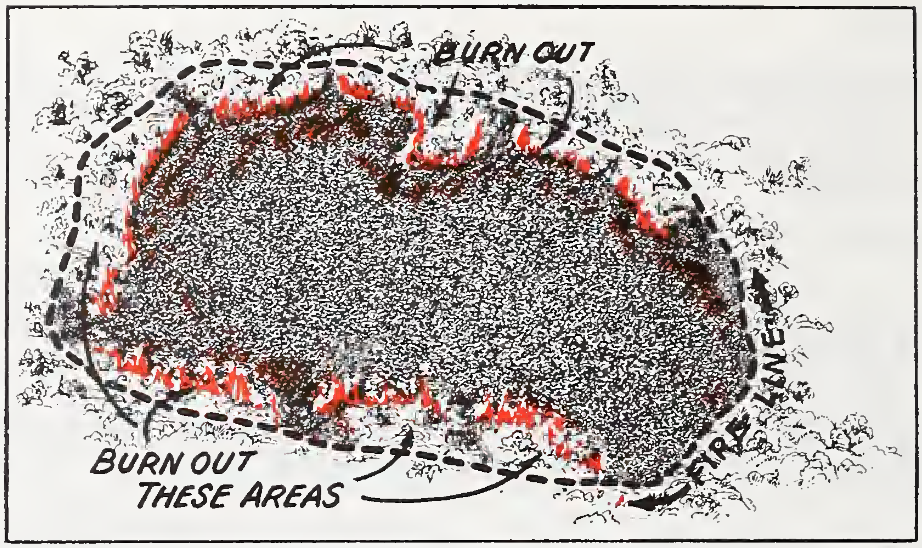


Figure 10.

Condition

Fire burned with ragged edge and many fingers. Fireline cuts across the tips of the fingers, leaving unburned material between fireline and ragged edge of fire.

Action Required

Burn out the material between fireline and fire edge, preferably by burning back from the fireline.

Why

To remove the danger of the fire flaring or spotting across line during late afternoon when burning conditions are worse, or when no one is near by.

Supplemental Action

A fire is never controlled until burned clean back from the fireline. Where clean burning is impracticable, as it is sometimes in brush types, fuel should be cut and removed.

UNBURNED ISLANDS IN A SMALL FIRE, WITH COVER
HEAVY ENOUGH TO THROW SPOT FIRES

Figure 11.

Condition

Fire did not burn hot enough to get a clean burn and several small islands of singed brush remain within the final control line.

Action Required

Build continuous control line around the outside of each island to keep them from burning later. If they consist of small patches of singed reproduction or brush close to the outside control line, cut the brush and reproduction down, if this can be done with a reasonable amount of effort. Check island carefully for hotspots.

Why

To remove the possibility of the fire later moving into the unburned or incompletely burned areas and spotting over the control line. To make a barrier down to mineral earth around all burned areas.

HOW TO HANDLE SPIKE-TOPPED TREE OR TALL SNAG SHOWING SIGNS OF FIRE WITHIN FIRELINE

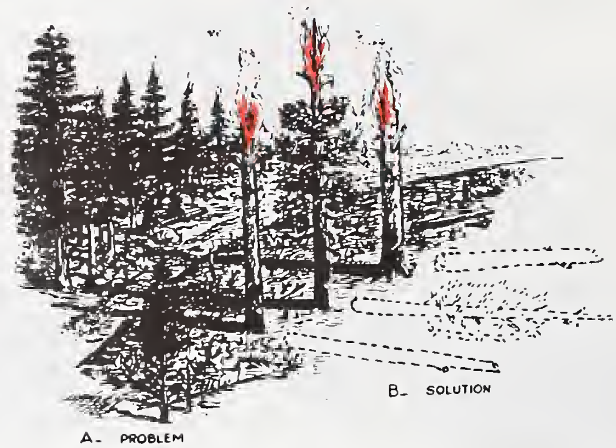


Figure 12.

Condition

Several snags and a spike-top (dead-topped tree) are located within the fireline and have smoke or fire showing in their tops. No sparks are falling or blowing over the line at the present time.

Action Required

The spike-topped tree and the snags should be felled away from the fireline and all burning material cut out and removed from main portion of the tree.

Why

To eliminate the danger of spot fires from sparks which may blow across the line because of a change in wind direction or velocity.

Supplemental Action

Any dead-topped tree or snag which has been subjected to hot fire is likely to hold fire, and is potentially dangerous; any trees of this type near enough to fireline to throw sparks across line in high wind, should be felled, examined carefully, and extinguished if they are found to have any fire.

HOW TO CONTROL SMALL SPOT FIRE OUTSIDE THE FIRELINE

Figure 13.

Condition

Small spot fire has been found at some distance outside fireline.

Action Required

Take immediate action to control the spot fire. Construct substantial fireline around the spot fire and if possible, put it completely out.

Why

To prevent spread of the spot fire, thus saving work already accomplished on main fireline.

Supplemental Fire

A trail should be marked from spot fire back to main fireline and sign posted there to call attention to existence of the spot, so it will be checked again later. This sign can be just a sheet out of your notebook saying "Spot fire 50 feet west."

52.6 - Patrol. Patrol is that portion of the mopup job which consists of moving back and forth over control line and edge of burn to check for and put out a fire that may burn or blow across the line and at the same time check for and put out any spot fires outside the line.

Firefighters are sometimes assigned to patrol for observation purposes with instructions to take prompt action on dangerous situations. Such patrol assignments may be made in the following situations: immediately after burning out--to check for and suppress spot fires; watch for spot fires near the line adjacent to burning snags which cannot be felled; on undercut line where rolling embers are likely to cross trenches; guard against breaks where heavy fuel such as snags, stumps, or log piles are being burned out; be on the watch for spot fires in spark-strewn areas outside the line; search for smokes during the later stages of mopup and for a period after mopup appears to be complete. Small smokes are generally most easily seen when looking toward the sun.

1. Organizing Patrol

a. Designate definite area for each firefighter.

b. Arrange for communication or signal between patroller and crew.

c. Have patroller work on, as well as watch, dangerous spots.

d. Designate special danger points to watch.

e. Systematize patrols so workers do not get together for "idle talk."

52.7 - Declaring the Fire Out. Before abandoning fire and as a followup, the incident commander will take the following steps:

1. Inside Fire. Within threatening distance of a line, check to see that:

a. All snags and spike-tops have been felled.

b. Logs and chunks are burned up or completely put out and surrounded by safe line; lying up and down slope; blocked with rocks so they cannot roll; or trenched immediately below on steep ground.

c. All stumps burned up or fire completely out; and checked if near fireline to be sure no roots cross the line.

d. All unburned patches of fuel surrounded by safe line or cold-trailed; burned out; or cut down and scattered.

e. All brush and reproduction with scorched dry crown cut down and scattered; or burned out with torch.

f. All smoldering litter, duff, or rotten wood scattered and burned up or extinguished.

2. Fireline. Check to ensure that:

a. Continuous, clean line is built to mineral soil. No roots at or near surface; no stringers of rotten wood or duff; no stringers of needles or leaves kicked across line.

b. No burning or smoldering material is left along fire edge.

c. No unburned patches left next to the line.

d. Undercut lines on steep slopes are trenched.

3. Outside Fireline. Check to be sure that:

a. Ground has been covered and inspected systematically in areas surrounding fire to make sure there are no overlooked smouldering spot fires. Some likely places to look are rotted logs, stumps, base of snags, up high in snags and spike-top trees, anthills, piles of bark, sawdust piles, animal dung piles, etc.

b. Area near line has been checked for surface roots which may come from stumps burned just inside fire. Any such roots found must be chopped out.

c. Spot fires have been completely extinguished and checked out.

d. Lava cracks or rock fissures have been followed up and checked to be sure fire in any duff or other fuel is out.

4. Fire Report. The agency's individual fire report should be filled in completely and accurately before leaving fire.

5. Followup. Within 24 hours after declaring the fire out, a designated firefighter should make a followup check of all fires handled by inexperienced people.

53 - SUPPRESSION OF CREW-SIZED FIRES

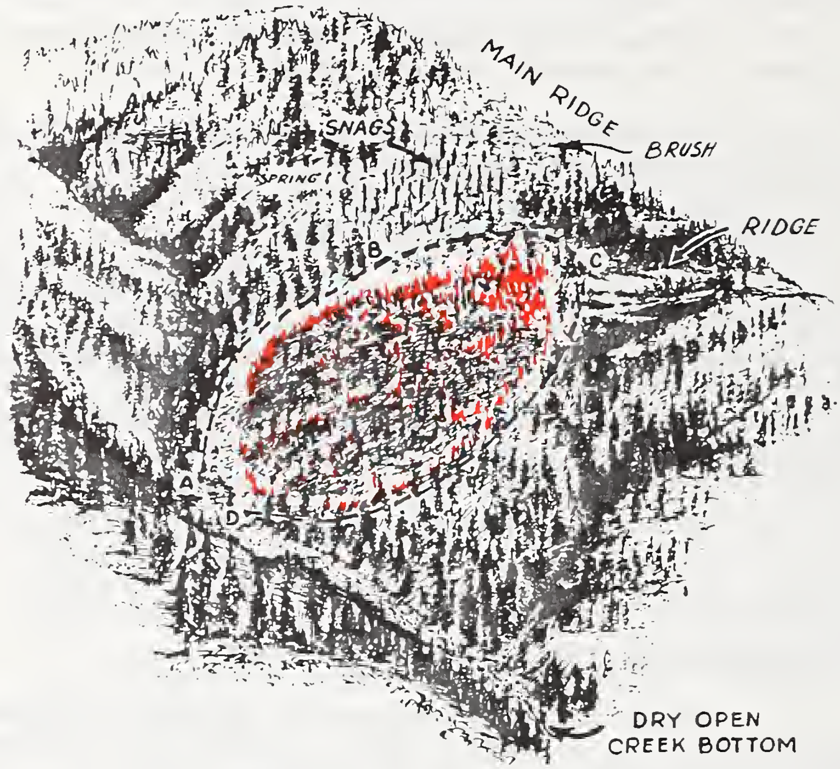


Figure 1.

Condition

Fire is reported to a leader of a 5-member suppression crew at 1500. The crew boss and crew left at once in an engine; on arrival found fire burning briskly in an open pine stand on a moderately steep slope. Fire was about an acre in size. The crew had to walk half a mile from the road to the fire. They took a felling outfit, McLeod tools, Pulaski tools, shovels, axes, fusees, canteens, headlights, hard hats, fire shelters, portable radio, belt weather kit, and rations for two meals.

Action

(Note: For ease of writing/reading, the pronoun "he" is used with the understanding that it includes male and female alike.)

1. Having sized up the general topography, cover, and weather conditions on the way in, the crew boss found on arrival fire had backed down into a dry creekbed and was threatening a side canyon (line A-B of sketch). He reported conditions to dispatcher by radio.

2. He assigned three firefighters, two with McLeod tools, one with shovel and ax, to make a direct attack starting at the lower edge of fire from creekbed up left flank (line A-B) instructing them to hotspot the line and prevent the fire from crossing the side canyon.

3. He took one firefighter who had a McLeod tool and started scouting along the right flank of the fire (line D-C). On reaching the top of ridge they found that the head of the fire was over a small spur ridge. Just beyond was a group of snags. Not far beyond was a dense brush patch.

4. He started the McLeod-tool firefighter to work constructing a line to mineral soil between the snags and oncoming fire, indicating where line should go (line B-C), with instructions to keep a careful watch for spot fires.

5. Going back to top of spur ridge at B, he called down for two people to come at once and help construct the line to cut off head of fire. He instructed remaining firefighter to continue hotspotting the left flank of fire (line A-B), and to maintain a careful watch of conditions along the line to see that fire did not flare up and cross the line.

6. He then helped the three people complete a control line across and in front of head of fire (line B-C) and down right flank for a short distance on line C-D. This line was burned out as soon as constructed, beginning just below spur ridge (near C), and continuing around to meet the firefighter on line A-B who by this time had reached the spur ridge at "B."

7. He had been watching all of the time for spots over the line, but since the run of the fire was not fast and the fuel type had not created sparks, none were found.

8. After the burning-out fire had burned back to meet the main fire and started to cool down, he left one person with a shovel to patrol and improve the line A-B-C.

9. He selected and marked location of line down right flank of fire (line C-D) to tie in to creekbed at lower edge of fire (D).

10. He used three people to construct this line, firing out downhill as line was built. He maintained a careful watch for spot fires over the line as firing progressed down the hill.

11. When burning out was completed, he left one person with shovel to mop up this line and watch for spot fires.

12. After starting the other two firefighters on improving the line A-B, he set up the radio and reported to dispatcher fire had a line around it, mopup work started, and control was ensured in the absence of some unexpected change. He asked that two dependable firefighters be sent to fire to relieve his crew during the night, because there was much mopup work to be done.

13. After checking area ahead of fire, well outside of the line, for spot fires, he then scouted inside of burn for snags and trees with fire in them. He found only one snag of fire in center of burn. Snag was not throwing sparks at that moment, but must be felled.

14. Returning to line A-B, he found the two people had completed the fire trench. As these two had been working hard, he had them take a rest at a location near point B where they could watch the line, while he scouted for and found a spring in a side canyon as shown on his map. He marked a trail leading to it so water could be obtained for mopup of fire.

15. Returning to the fire, he instructed the two mopup people to continue with the mopup inside the line. After again checking area outside of line and well ahead of fire, he returned to line A-B where two workers were resting.

16. Taking these two and the felling outfit, he proceeded to the snag to be felled. After sizing up the situation and deciding on a safe plan of action, he had them go through a dry run of safety precautions including escape route. He alternated with the workers in felling the snag. Two sawed while one acted as lookout for falling limbs, burning embers, and other hazards.

17. With the snag down, the two were sent to the truck to bring two backpack pumps and sleeping bags for all firefighters.

18. He then checked progress of mopup work being done by the other two people. He saw that all weak line had been or was being strengthened, all logs that might roll were turned upslope, burning materials were being scattered well inside the burn, no sharp angles or turns left in lines, and all material close to the lines was burned clean, except for a few isolated logs.

19. With the arrival of the two people with backpack pumps, mopup work was speeded up. Since the area was small, the crew eventually covered the entire area, mopping up with water and dirt.

20. He took one more trip ahead of the fire, making a careful check for spot fires well outside of line, checking control line carefully and found all line in good condition.

21. About 2100, since all was quiet, he took entire crew back to open creekbed (line A-D) where overnight camp was made. All crew members ate and went to bed. The two fresh individuals sent out to patrol fire during the night arrived.

22. He took the night crew around entire fire, pointing out mopup work to be done, dangerous spots to watch and areas to check for spot fires. He instructed them to awaken day crew should conditions warrant. He then joined the crew in camp for the night.

23. At 0500 (daybreak) the crew members were awakened and ate breakfast. Mopup work was resumed. The crew boss worked with the crew, in turn making sure each person understood how to check logs and other partially burned material for live fire and how to treat each case and why. As the day advanced, he also took the actions listed below.

24. He made careful checks of all country near, but outside of the lines for spot fires.

25. He went over control lines, foot by foot, to be sure no burning roots crossed the line.

26. He inspected the tops of all trees to see that no punky places were afire.

27. He inspected all undercut lines to see that trenching was adequate.

28. He maintained periodic radio checks with dispatcher throughout the day in case he might be needed on another fire.

29. He made a paced survey of the fire and recorded the data needed for the fire report. This included the times of the principal steps in suppression, damage to timber, cover type, and other information.

30. No live fire was found after 1400, so at 1900, after making a final inspection of all key points, the crew left the fire as out. They marked the trail back to the road to aid the fire management assistant in locating the fire for the final inspection the following day.

a. Summary of correct practices used

(1) Fire was scouted.

(2) Fire weather was measured and considered.

(3) Attack was directed to proper key points.

(4) Lines were located and did not just grow.

(5) Lines were burned clean as they were built.

(6) Lines were patrolled after completion.

(7) Lines were mopped up promptly.

(8) Snags were felled promptly.

(9) Water and dirt were used in mopup.

(10) Radio was used

(11) Food and water were provided.

(12) Spot fires were searched for.

(13) Natural barriers used.

(14) Crew members were trained in proper method of mopup when possible.

BURNING OUT SECTION OF FIRELINE WITH SMALL CREW

Condition

Orders have been given to the crew boss to burn out line already constructed. Size of crew: 10 members. Equipment: two drip torches or flamethrowers, shovels, axes, extra fuel, lunches, and canteens. Time: early evening, midseason. Burning conditions moderately favorable; gentle breeze. Mature timber with normal litter and some brush.

Action Required

(Note: For ease of writing/reading, the pronoun "he" is used with the understanding that it includes male and female alike.)

1. Crew boss checks fire weather elements with belt weather kit.

2. Crew boss takes crew to highest point on line.

3. He assigns one person with shovel and one with ax to scout just ahead of torch carrier, along line to be fired. He instructs these people to examine the area along and adjacent to the inside of the line and clear around snags, logs, and dense cover which will create dangerous situations if ignited by the backfires. The person with shovel is instructed to cover dangerous stumps and log ends outside the line with dirt. These people are told to keep close to the firing operation in order to use the burned area as a safety island.

4. He assigns two firefighters to start burning out and starts them from high point down, instructing them how far to proceed before stopping for further instructions. He tells them to burn out around the cleared snags, logs, and stumps before firing the main line. Fire will then burn away from these critical fuels instead of toward them. Those who are doing the burning are told to maintain a safety island close to them as they progress.

5. He assigns five shovelmen and one axman to follow the burning, assigning one of these as a squad boss.

6. He instructs squad boss to follow backfiring as it proceeds and to assign each shovelman a designated section of the burned-out line to protect against spotting or flareover. Instructs them to take care of such situations by cooling the hotspots and flareups with dirt, and how to put firelines around all spot fires. Instructs people how to give the alarm if there is a break.

7. He goes back and forth constantly along the burned-out sections of line, inspecting with the squad boss the work of the shovelmen. In order not to delay burning out, he sees that only work necessary to hold fire is done, leaving complete mopup until later. He moves crew forward to freshly fired sections as soon as their sections have cooled down. That way, only occasional patrol is necessary.

8. He regulates the speed of burning so no more line is fired than can be adequately patrolled by shovelmen.

9. He continues the burning out by stages until entire assignment is completed.

10. He drops off additional patrollers as needed to safeguard line.

Supplemental Action

1. It is the crew boss's responsibility to get as complete a burn as possible. When fired stretches go out or burn in patches, he must have shovelmen pile and ignite dry material to get fire started. Or he may get a second burnout farther inside the line in readily ignited material. Uses flamethrower in locations difficult to ignite.

2. Time is important. Keep firefighters working at the speed necessary to complete the entire firing job before burning conditions become too poor for ready ignition and burning. In early morning, speed is essential to complete the job in time to allow the line to cool down to point of safety before the wind and temperature rise and the humidity drops, bringing dangerous burning conditions.

3. Make it a rule that workers remain on their assigned units of line when eating lunches, so as to leave no line unattended. Water should be distributed to people when initial supply is used up.

4. In situations where humidity rises so burning will no longer take hold, the crew boss should report progress and conditions to the next level of command and get direction for the crew.

MOPPING UP HILLSIDE LINE ON LARGE FIRE

Condition

Crew boss with 20 crew members and 4 squad bosses have been assigned to mop up one-half of hillside line on a large fire. There are about 10 snags to fell inside fireline, varying from 20 inches to 48 inches in diameter; many stumps to trench; several logs which can be moved and a few large logs burning near the fireline; much small stuff burning along fireline; several patches of scorched manzanita along edge of fire; several burning stumps that can be put out with water; and a few stumps adjacent to outside of line opposite hot stuff inside. Time: Daybreak. Required to make safe before burning period (1000) and thoroughly mopped up by evening. Members are equipped with proper tools and personal protective equipment.

Action

1. Crew boss assigns three people, each equipped with ax and shovel and with one backpump for the unit, to dangerous points along line. Establishes definite patrol sections for each person. Instructs all to check constantly along the edge of the fire both inside and outside, and to do emergency mopup work at most dangerous points to hold fire in check until arrival of the main forces.

2. Organizes 14 people for working as 3 units on mopup. Equips each person with shovel; also two Pulaskis and a backpack pump in each unit. Places a squad boss in charge of each unit and instructs them to work their units along the fire edge both inside and outside, taking care of the most dangerous material next to the line on the first trip through. On the return trip they will thoroughly mop up to the desired distance from fire edge. Also instructs squad bosses to:

   a. Trench burning stumps, taking care of most dangerous ones first and cutting off burning roots extending towards line.

   b. Turn logs to prevent rolling, trench and block large logs, and move or separate log piles.

3. Organizes felling crew of three people with one designated as a squad boss, equipped with felling tools and a shovel. One lookout will watch for falling limbs and chunks while the other two fell snags. Shovel to be used for cooling down base of snags. Starts crew on snags which are the worst fire hazards first, if they can be handled safely.

4. After crew boss has organized the crews and set them to work on the ground, constantly works between units to supervise and inspect their work, then changes the plans as the situation demands.

5. When any unit completes its assignment, members are reassigned to other duties.

a. Summary of correct practices used. To identify specific dangers and to see that they are eliminated is the continuing job of the crew boss. These duties usually include:

(1) Mopping up far enough inside fire for safety.

(2) Preventing possible roll across line of material such as logs, chunks, and yucca plants.

(3) Hastening burning out of duff and heavy fuels.

(4) Extinguishing with water and dirt.

(5) Removing scorched brush or reproduction from edge of fire.

(6) Covering up punky logs and stumps outside line.

(7) Falling burning snags and putting out fire in them.

(8) Watching for spots and burning snags outside them.

(9) Feeling for hot stuff before assuming any part of fire is out.

(10) Cutting off burning roots that extend toward line.

(11) Instructing crew in safe working practices.

54 - FIRE SUPPRESSION ORGANIZATIONS

54.1 - Smokechaser Fire. When two people attack a small fire, one is "in charge," or, is the incident commander (Figure 1). Three tasks have to be done.

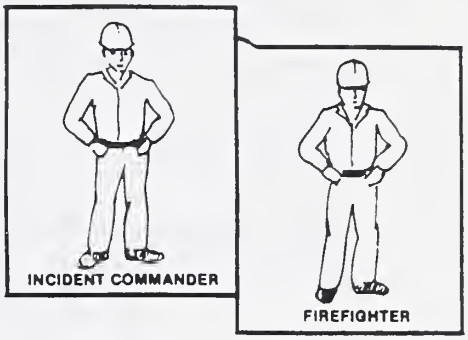


Figure 1.

1. Get to the fire with the right tools to do the job.

2. Size up the fire and decide what to do. This is the planning phase of the job.

3. With the other individual, put a line around the fire and put it out. This is the doing phase of the job.

54.2 - Small-Crew Fire. Normally a small-crew fire has about six firefighters (figure 1).

In a two-member attack on a fire, one person is the incident commander (I.C.) This is a working leader, who must plan the attack, supply the equipment, and execute the plan. In figure 1 (below), the incident commander supervises the workers directly. The I.C. is in charge of a small crew or attack unit. If a tractor plow or dozer is used, they may organize with an operator, firing boss, and two or more line-holding positions. An engine attack might be organized with an engine operator, hose pullers, and nozzle operator. Even in this simple single-attack-unit fire, organization is necessary.

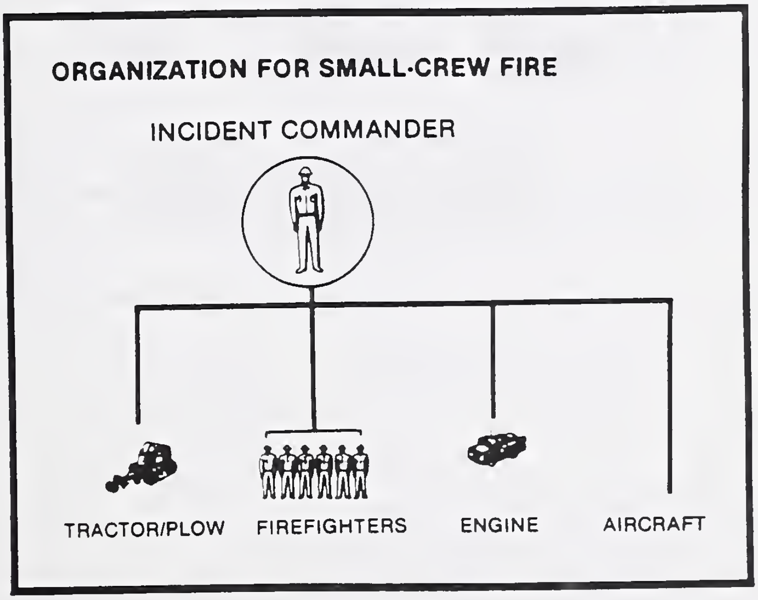


Figure 1.

54.3 - Medium-Crew Fire. Normally a medium-crew fire has about 14 firefighters (figure 1).

In an attack of this size, the incident commander may divide the workers under squad leaders. If the attack is made with engines, the I.C. deals directly with the engine boss. In case a dozer or tractor-plow unit is available, the I.C. directs its work.

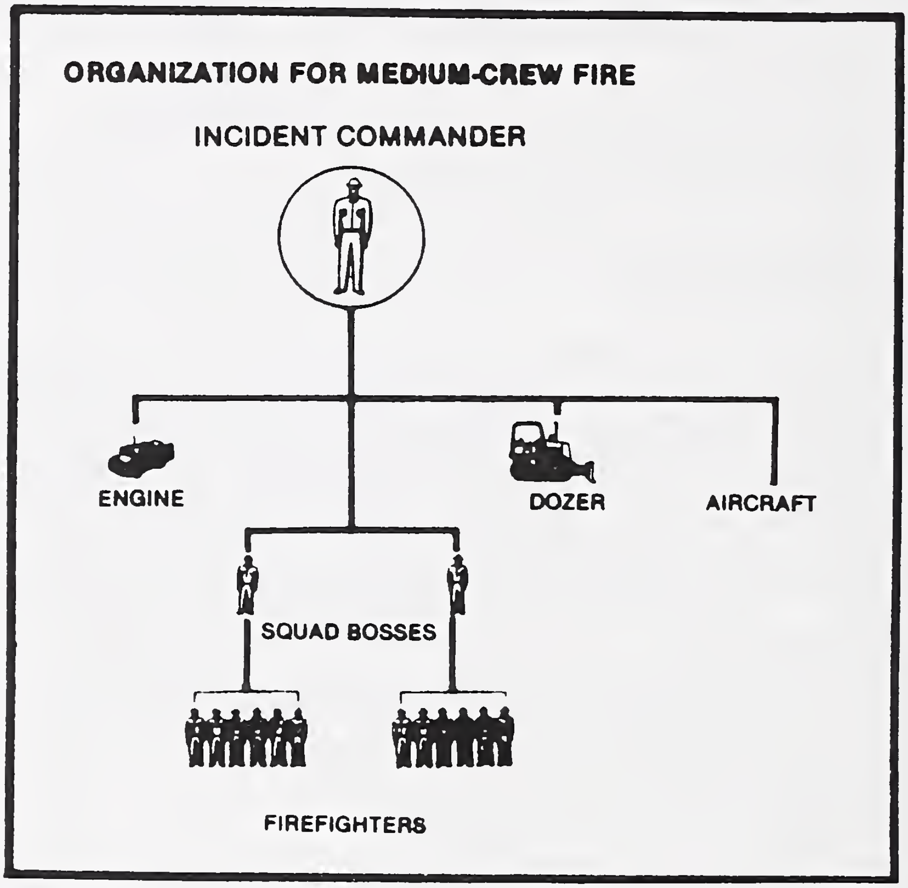


Figure 1.

54.4 - Large-Crew Fire. Normally a large-crew fire has approximately 21 firefighters (figure 1).

Here the incident commander divides the workers into squads, supervising them through a crew boss. If engines make the attack the I.C. may supervise them directly through the engine boss. Dozer or tractor-plow units would be managed by a dozer boss who would get directions from the I.C. With this size organization the I.C. may lend a hand here and there but must not "get his head down" and lose contact with the overall situation. The leader's job (I.C.) is not only to direct the attack, but to look ahead and inform the dispatch source of further needs.

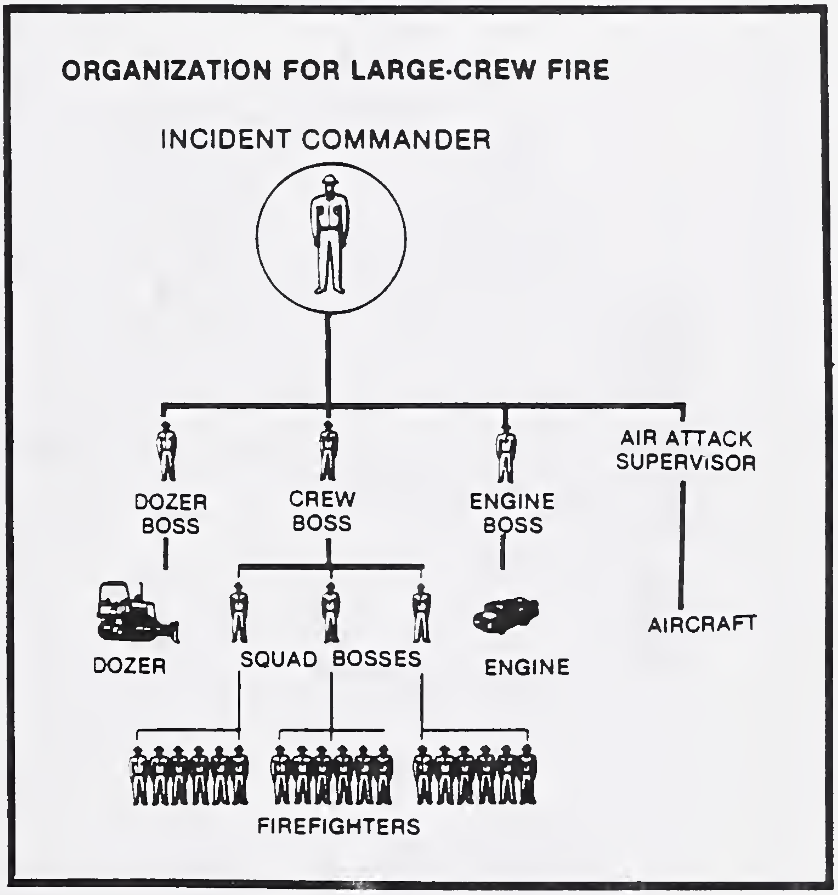


Figure 1.

54.5 - Multiple-Crew Fire. Normally a multiple-crew fire has about 63 firefighters (figure 1).

In this organization the incident commander has activated a logistics section, a finance section, and the field observer in the planning section. The logistics section is headed by the facilities unit leader and has helpers, cooks, and tool manager. The finance section has a time unit leader. The operations work is directed through crew bosses and/or engine and dozer bosses. The incident commander does the planning with the assistance of the resources unit leader. The I.C. is still able to handle the entire fire perimeter, acting as operations section chief.

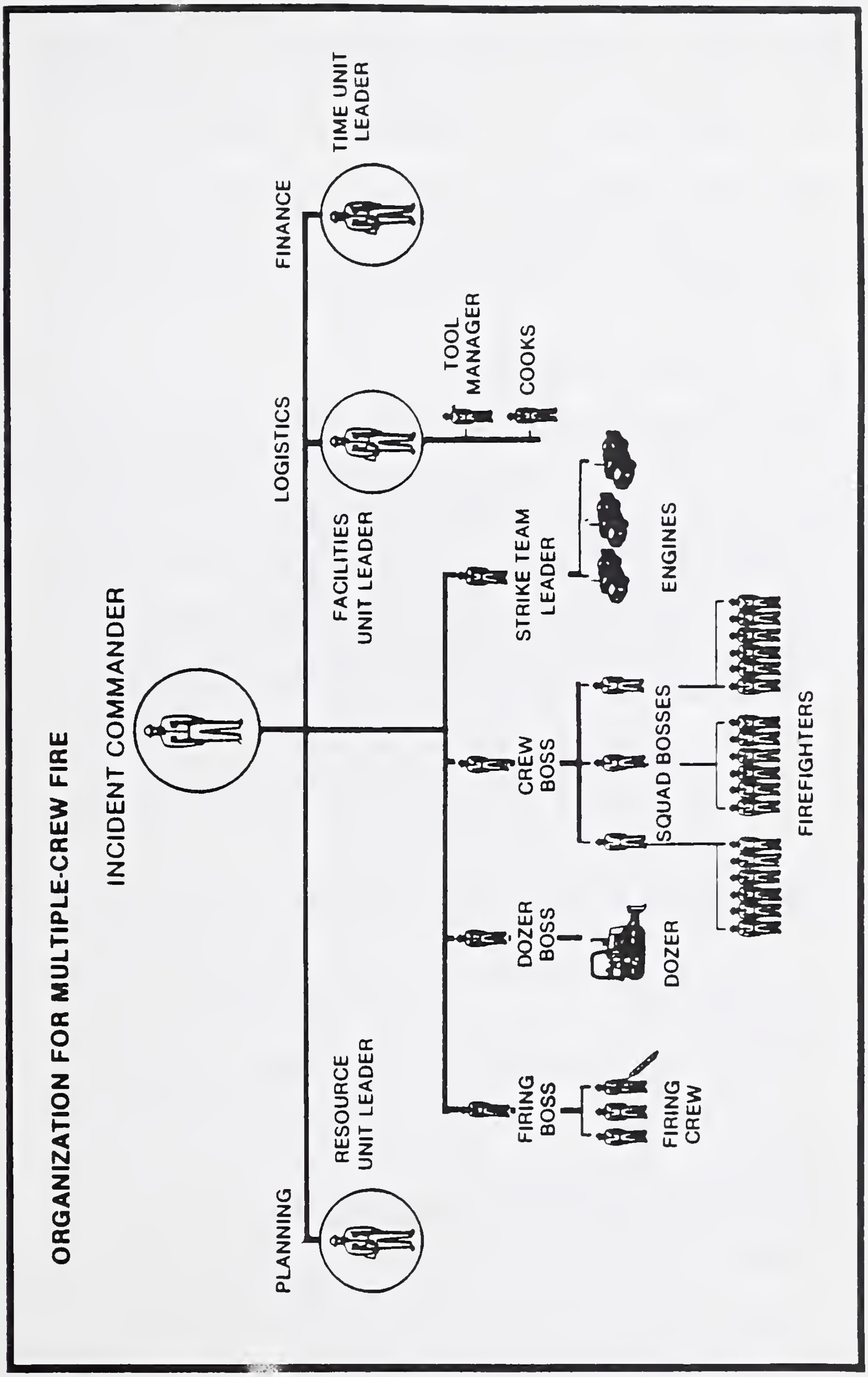

ORGANIZATION FOR MULTIPLE-CREW FIRE
INCIDENT COMMANDER
PLANNING
RESOURCE UNIT LEADER
LOGISTICS
FACILITIES UNIT LEADER
FINANCE
TIME UNIT LEADER
TOOL MANAGER
COOKS
FIRING BOSS
FIRING CREW
DOZER BOSS
DOZER
CREW BOSS
SQUAD BOSSES
FIREFIGHTERS
STRIKE TEAM LEADER
ENGINES

Figure 1.

55 - LARGE FIRE DUTIES

55.1 - Squad Boss. The squad boss is supervised by the crew boss as a working leader of a small group, usually not more than six firefighters. The squad boss is responsible for keeping squad members fully employed on jobs assigned by the crew boss.

Squad bosses may be used on all fires requiring more than six line workers. Situations when qualified squad bosses are particularly needed include: night work; with inmate crews or newer employees; steep terrain; when fuels, weather, and topography indicate critical fire behavior.

The duties of the squad boss are:

1. Understanding exactly what the crew boss wants done.

2. Seeing that crew has first-aid kits, personal protective equipment, files, and other necessities before leaving camp.

3. Seeing that firefighters do a reasonable day's work.

4. Seeing that no effort is wasted on unnecessary work.

5. Keeping workers equipped with proper tools.

6. Showing workers how to use and care for tools.

7. Helping crew boss in off-the-line and base or camp duties.

8. Assisting the crew boss in checking people out and in with the timekeeper.

9. Keeping a list of names of people and keeping time if requested by crew boss.

10. Looking after the safety of the workers on the line.

11. Reporting lazy and incompetent workers and agitators, to the crew boss.

12. Observing and enforcing smoking rules.

13. Looking after safety of workers during transportation.

14. Seeing that the workers have lunches and water.

55.2 - Crew Boss. The crew boss is responsible for the performance of the crew, its safety and welfare. Usually retains the same crew for the duration of the fire; hence has responsibility for them both on the line and off the line. Will remain on line until instructed to leave.

1. On-the-line duties of the crew boss are:

   a. Explaining at the beginning of each shift:

      (1) The nature of work to be accomplished.

      (2) Expected duration of the shift.

      (3) Chain of command and who issues instruction.

   b. Organizing the crew to efficiently accomplish specific tasks.

   c. Locating and assigning individual tasks to squad bosses or crew members within the assigned section of line.

   d. Explaining and/or demonstrating techniques of accomplishing the tasks safely and efficiently where crew members are inexperienced or unskilled, such as providing current on-the-job training to ensure acceptable performance.

   e. Stimulating squad bosses and crew members to attain quality and quantity accomplishment.

   f. Providing first-aid treatment for minor injuries.

   g. Frequently inspecting the area assigned to ensure required standards of performance.

2. Off-the-line duties of the crew boss are:

   a. Retaining the crew as a unit, keeping them so mobilized as to answer any request with the crew intact at any time.

   b. Inspecting physical condition, clothing, personal protective equipment, and equipment of crew members prior to leaving and immediately after arrival at base after each shift. Taking such action as indicated to maintain crew in usable condition.

c. Preparing and maintaining time report in duplicate showing:

(1) Names of crew members.

(2) Time slip number.

(3) Origin of crew.

(4) Hours on duty.

(5) Pay classification.

d. Supervising crew while being transported between fireline and base or camp.

e. Learning, from bulletin board or registrar, layout and routine of camp feeding, sleeping, commissary, sanitation, etc. Instructing crew members and keeping them under control.

3. <u>Special duties</u> the crew boss should perform are:

a. <u>See about equipment</u>

(1) Are tools O.K.?

(2) Get water and lunches.

(3) Get first-aid kits.

(4) Is transportation safe?

b. <u>Travel safely</u>. Drive carefully. Walk properly. Carry tools correctly (figure 1.)

Figure 1.--Travel safely.

c. Look ahead. Find escape routes or safety routes or safety areas.

Tie in with adjoining crews.

Anticipate needs.

d. Manage the firefighters. Keep them spread and working (figure 2).

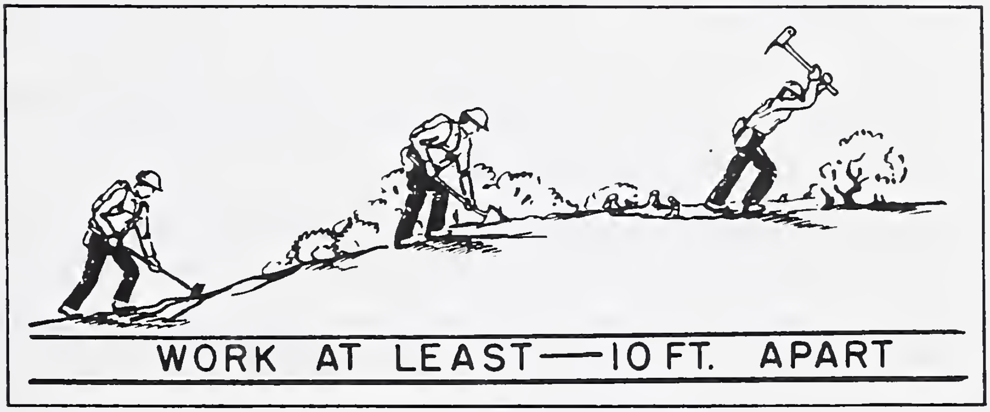


Figure 2.

e. See that first aid is given to injured.

<u>56</u> - <u>AIR ATTACK ON FIRES</u>. Use of aircraft in fire suppression is important. If used at the right time and place with proper followup, large fires may be averted and a real savings in suppression costs can be realized.

<u>56.1</u> - <u>Smokejumpers</u>. These skilled firefighters can make quick initial attack on fires at almost any location. They are especially effective on fires that would take ground crews hours to reach.

<u>56.2</u> - <u>Helitack Crews</u>. These are crews delivered to or near the fire by helicopter and especially trained for this purpose.

It is important for all firefighters to know safety requirements of helicopter travel because they may be transported by helicopter. A few cautions are:

1. Stay away from helicopter when rotor blades are in motion unless authorized by pilot.

2. Always approach or leave from front side in view of the pilot.

3. Always approach or leave a standing or hovering helicopter from side where ground is lower.

4. Stay away from the tail rotor.

5. Secure a hard hat with chin strap or hold in hand when approaching or leaving helicopter when rotor blades are in motion.

6. If a helicopter is picking you up in an isolated or other unimproved touchdown spot, indicate the wind direction to the pilot with dust, streamers, handkerchief or other available means.

7. Do not smoke.

8. Do not carry handtools on board.

9. Secure supplies you may have with you to avoid being blown away.

<u>56.3</u> - <u>Air Tankers</u>. These are used to deliver retardants onto fires. This is a direct method and is most successful when used on initial attack. Once the fire has reached the stage requiring indirect attack, the effectiveness of air tankers is usually diminished.

There are times when a firefighter will be the first and only person on the fire. The dispatcher will request an opinion for need for air tanker attack. Some things to remember are:

1. There will be some lapsed time between the firefighter's decision to request tankers and arrival of the tanker--probably about 15 minutes plus flight time. A firefighter cannot wait until it is needed to order it. (The most common error is failure to recognize this and order too little too late.)

2. A firefighter must decide if the fire can be controlled or held until other help arrives.

3. Decision must be a positive yes or no. If the need is likely there is no time for indecision.

4. Proper use in time could save many dollars.

5. Decide how many air tankers are needed and where the retardant should be applied.

56.4 - Retardant Drops. Personnel can be injured by the impact of retardant dropped by low-flying aircraft.

Be in radio contact with the aircraft if possible. Clear people out of the target area when retardant drop is to be made. If unable to retreat to a safe place, the safest procedure is to:

1. Lie face down, with head toward oncoming aircraft and hard hat in place.

2. Discard handtools to the side, behind and downhill and not in the path of someone else.

3. When lying on the ground, grasp something firm to prevent from being carried or rolled about by the potential impact of the dropped liquid.

4. Never run unless escape is ensured.

5. When in timber, stay clear of snags, dead tops and limbs in drop area. Do not remain in area if there are rocks or other material that may be dislodged by the retardant drop.

6. Wipe retardant off tool handles before resuming work.

Take aggressive action after retardant is dropped--retardants will not do the job alone. They delay a fire long enough for construction of the needed control line. Too often ground crews have lost the benefit of retardants by not promptly getting back to work on the fireline after the retardant drop.

Be alert to successive drops--take safety precautions before and followup with line construction after retardants are dropped.

56.5 - Helicopter Bucket Drops. Helicopter bucket drops can be used to cool down hot spots along the fire edge in support of line construction. Bucket dropping operations must be followed up by prompt action from ground crews. Do not stand under or in the path of helicopters making bucket drops.

FIREFIGHTERS GUIDE

CHAPTER 60 - CARE, STORAGE, AND MAINTENANCE OF EQUIPMENT

Contents

CHAPTER 60 - CARE, STORAGE, AND MAINTENANCE OF EQUIPMENT

Agency objectives and policies on fire control equipment are stated in agency manuals or handbooks.

The purpose of this section is to aid firefighters in maintaining fire control equipment in good serviceable condition. Complete maintenance details are not given for each equipment item. Sufficient information is furnished as guides for care, storage, and maintenance. References are made to other handbooks and training courses containing pertinent maintenance information.

The terms "care" and "storage" are used herein include conditioning, preservative treatment, stamping or labeling, packaging, arrangement, and storage.

61 - EQUIPMENT

61.1 - Handtools. Most effective fire control work is possible only with tools that are in good condition. The finest ax is worth very little if in poor condition, and is dangerous if dull, or loose on the handle. Users are personally responsible for keeping in the best possible condition all equipment assigned.

61.11 - Care and Maintenance. Tools should be checked to make sure they are in proper condition, and handles are tight. All tools should be reconditioned immediately after use so they are ready for the next fire. This includes coating axes, shovels, and similar tools with quick drying primer for rust prevention while tools are stored.

Most cutting/scraping tools are equipped with sheaths on the cutting edge. A plastic sheath is common and is disposable. However, other sheaths such as metal or leather may be used and should be kept for later use.

61.12 - Tool Handles. Handles should be kept smooth with fine sandpaper. If possible, they should be protected from exposure to weather while stored. Common defects are slivers, cracks, excessive twist or warp and poorly fitted to the tool. Tools with the above defects are unsafe to use and should be replaced or reconditioned.

61.13 - Sharpening. When sharpening axes and similar cutting tools, always be careful not to overheat the cutting surface. Grind to within one-fourth inch of cutting edge. Finish off with file or whetstone. Proper taper or bevel must remain as tool is shaped in grinding. Sketches that follow illustrate tools that have been properly sharpened and maintained.

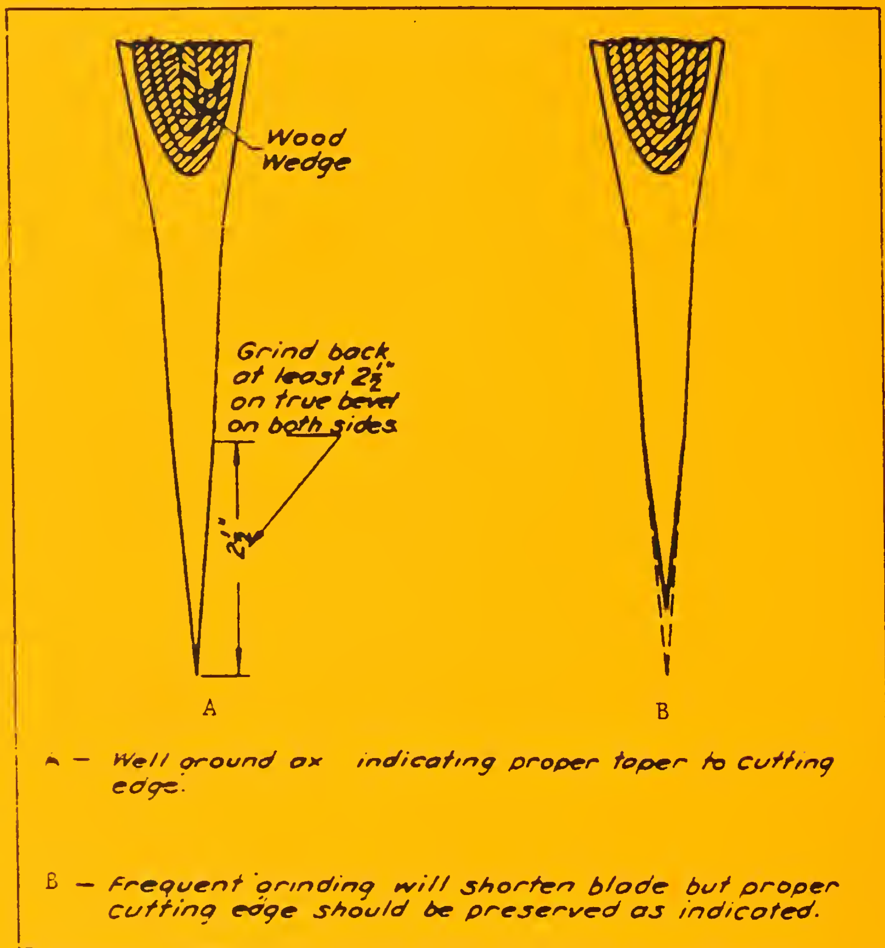


Figure 1.--Principles observed in sharpening axes.

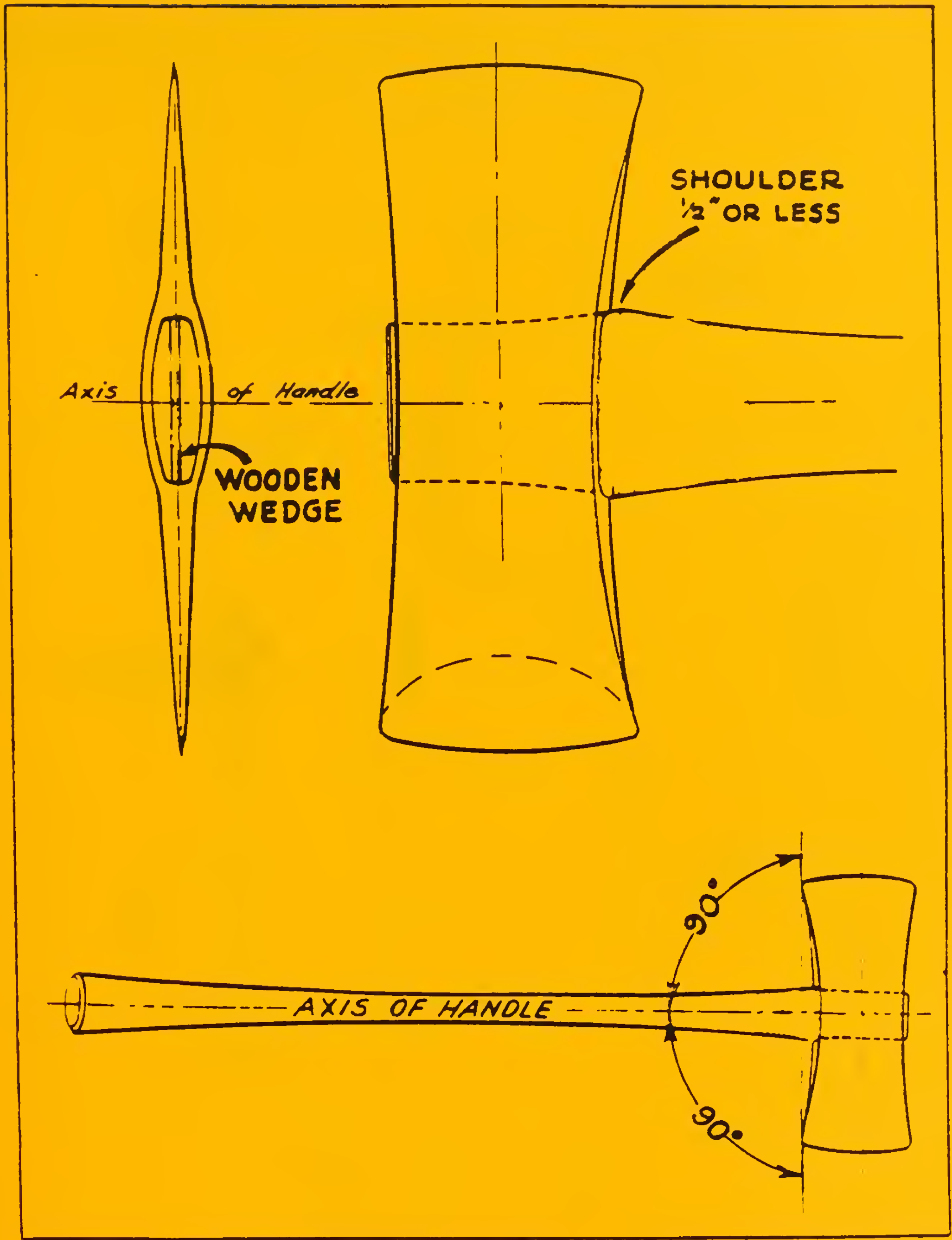


Figure 2.--Double-bit ax.

Ax bit to be ground with an even taper back from the cutting edge at least 2-1/2 inches. Hoe side ground to a good cutting edge, the bevel to be approximately 3/8 inch deep on the inside of the blade; that is, on the side facing the handle.

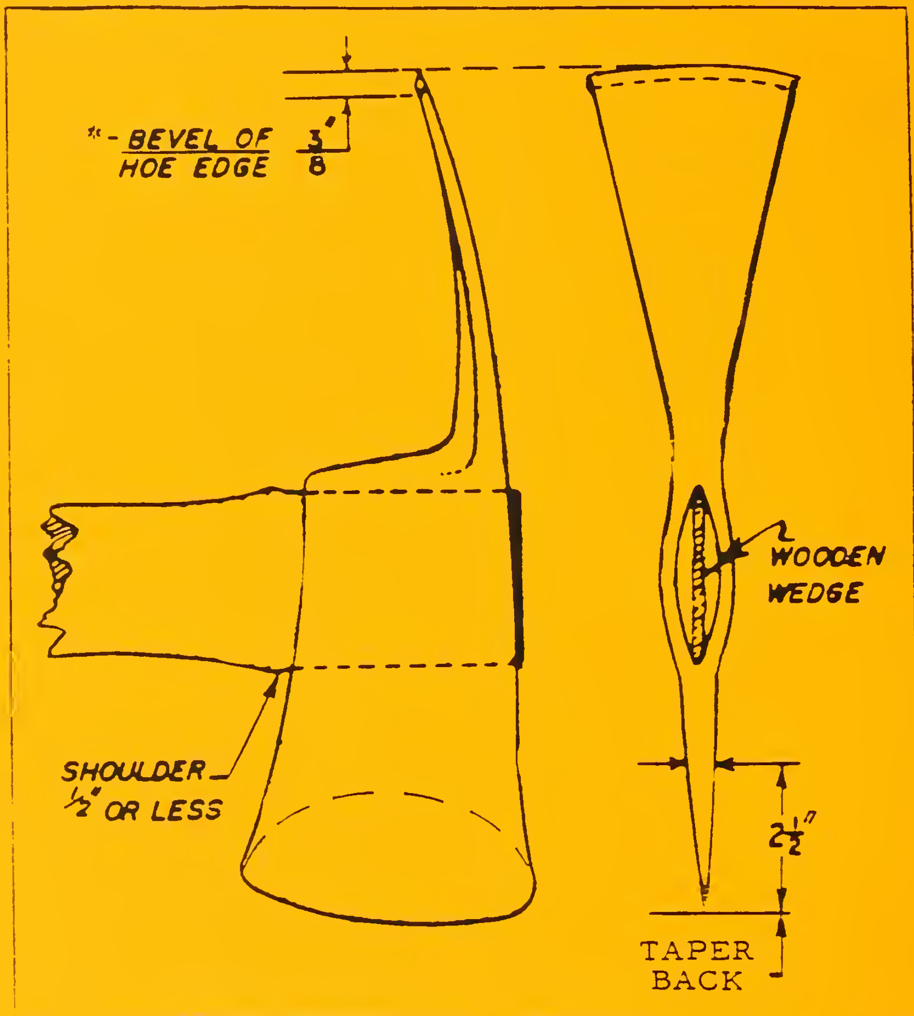


Figure 3.--Pulaski tool.

Grind both sides of the long portion of the cutting edge in an even bevel back from the cutting edge at least 1 inch. Take care to keep the circular pattern at throat. Carefully grind the throat back 1 inch on an even bevel. Grind hook or point on a bevel approximately 3/4 inch deep.

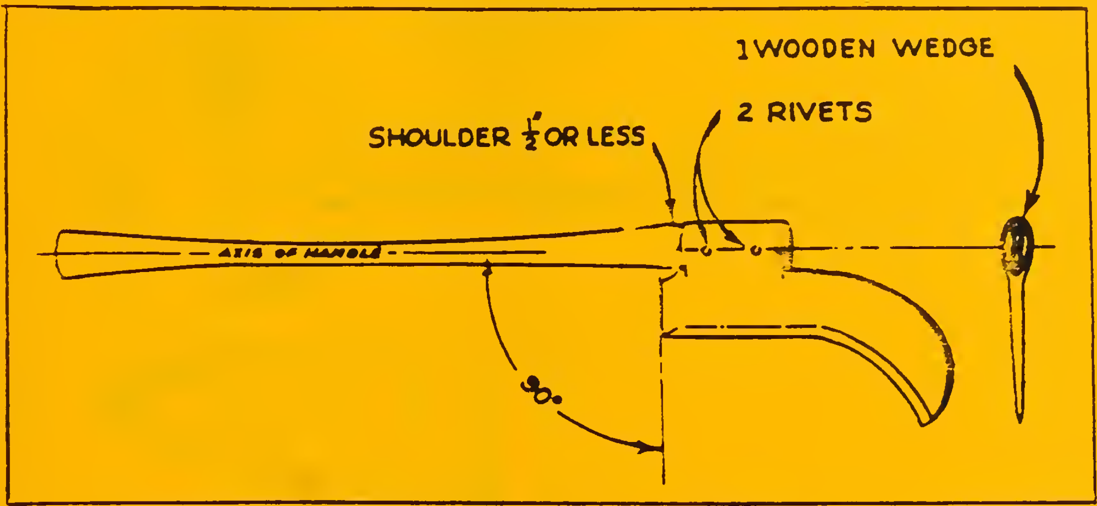


Figure 4.--Brush hook.

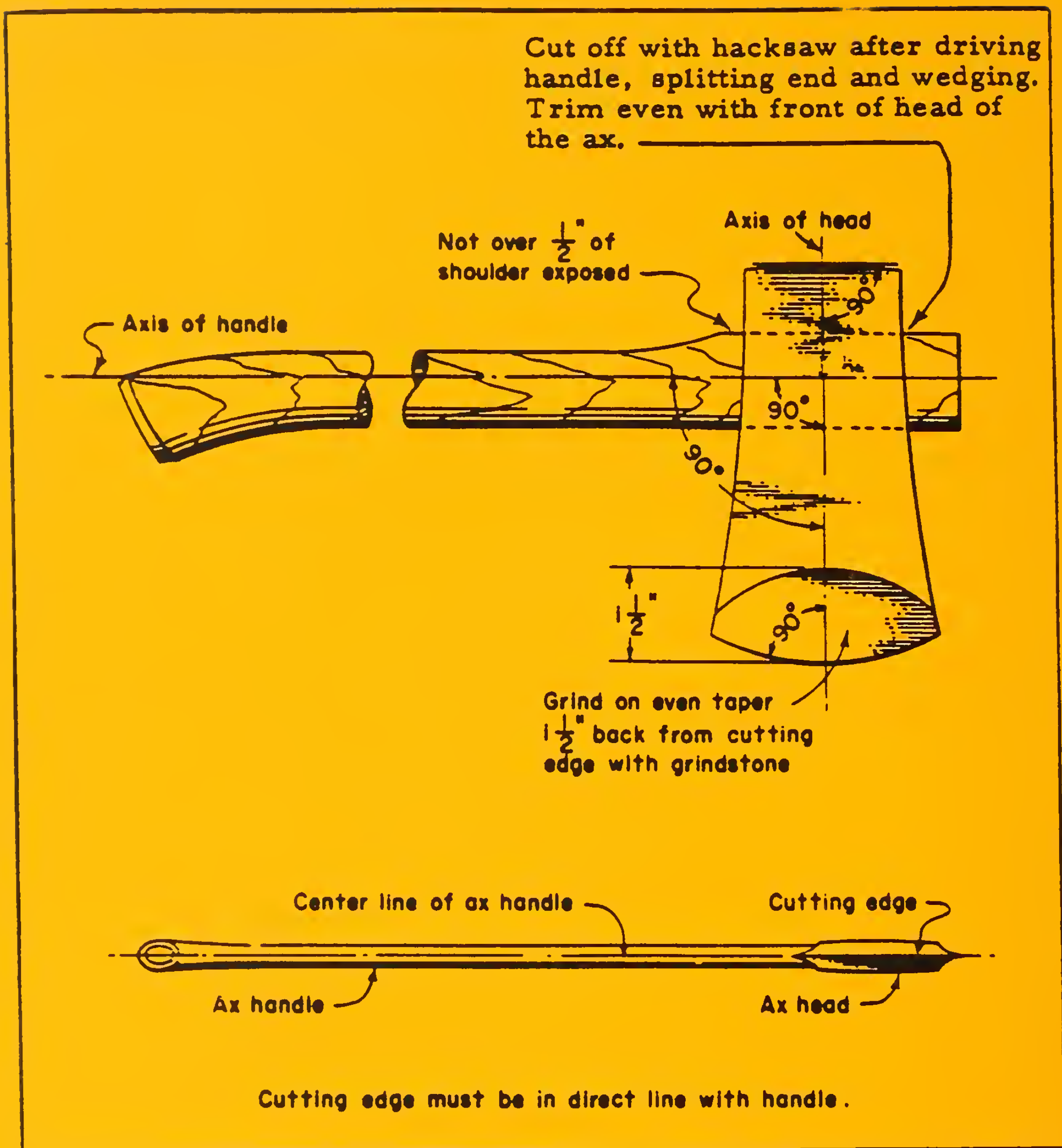


Figure 5.--Single-bit ax.

Each edge of the shovel is sharpened from the point to approximately 1-1/2 inches from the top of the blade, the bevel being on the inner face of the blade.

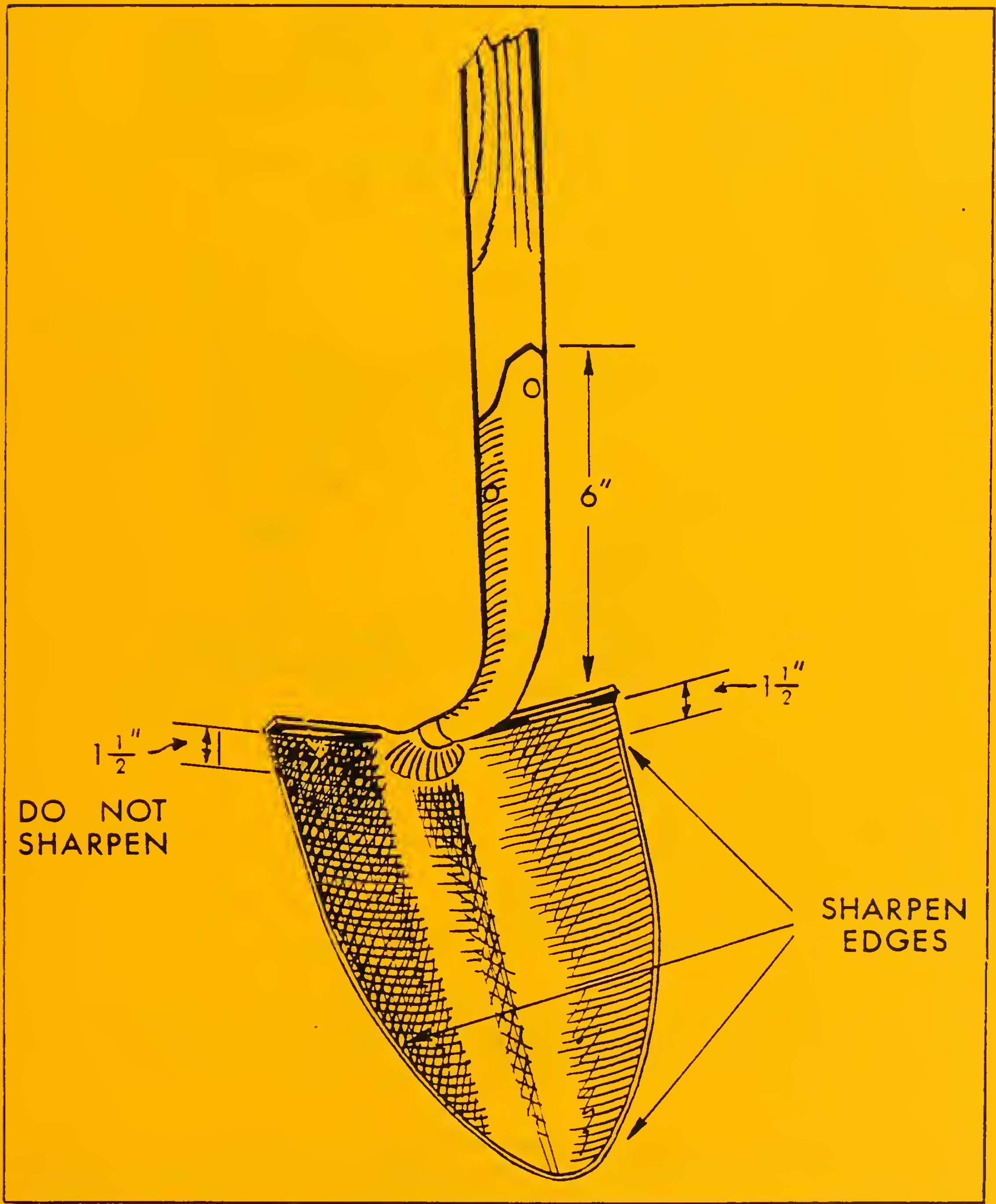
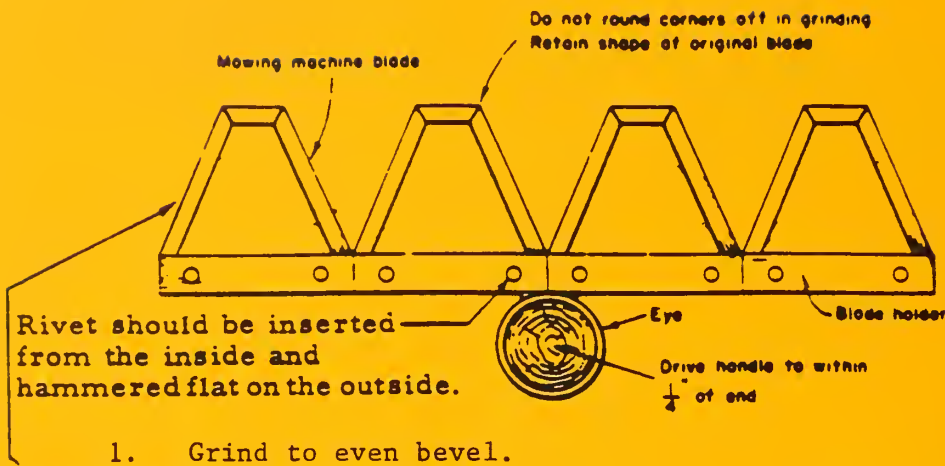


Figure 6.--Shovel size No. 1



1. Grind to even bevel. Keep edge keen and smooth. Do not use ordinary emory wheel.

2. Flat side of blade on inside (side toward worker).

3. Paint handle with 2-inch red band.

4. Oil cutting edge to prevent rust.

5. All grinding should be done while tool is firmly clamped into a special Council tool grinder. Do not use the ordinary emory wheel. The square point on the blade is retained by grinding on the straight stone which comes with the grinder. This action takes place after the sloping edges have been ground on the beveled rock. The straight rock is then placed on the grinder and the four points touched up.

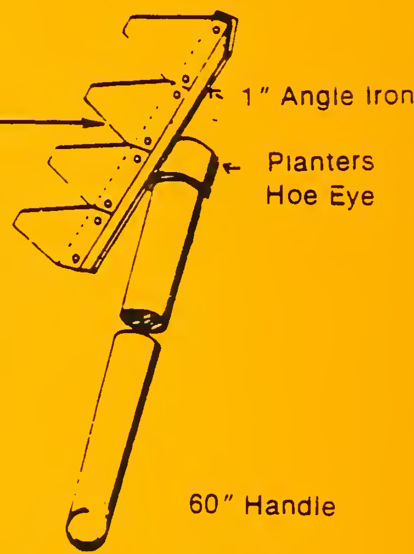


Figure 7.--Council tool.

Do not remove handles while grinding. Hold handle at point about 2 feet from blade and apply pressure while grinder is being turned. With other hand, operate slide to center blades on grinder.

The slide and clamp which comes with the average sickle grinder will not hold a council tool. The slide and clamp, from a Council tool grinder, will however fit a sickle grinder. Do not discard clamps or slides, since they seldom wear out and sickle grinding stones may be purchased locally to go with them.

Grind the hoe side so there is a good cutting edge on the inside face; bevel to slope outward at an angle of approximately 45 degrees. Bevel to be on outside of blade away from handle.

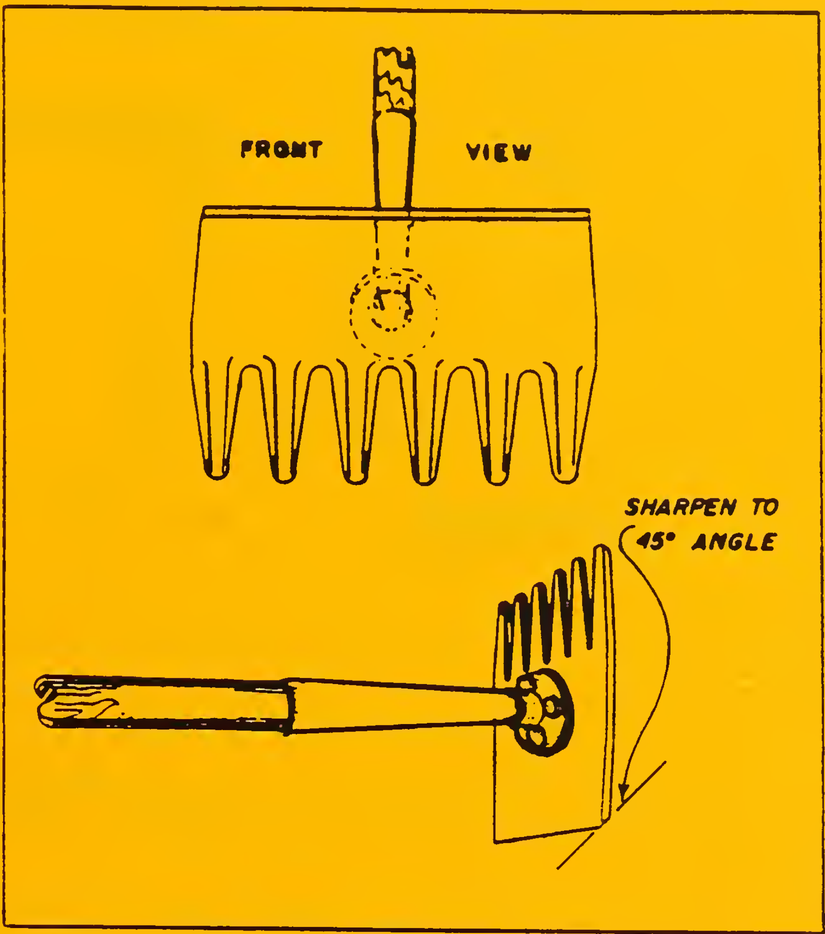


Figure 8.--McLeod tool.

Figure 9.--Mattocks and hazel hoes.

1. Grind hazel hoe and mattock bit on the inside to a minimum of 3/8-inch; 1/2-inch bevel is allowable. Grind to good cutting edge.

2. Grind cutter on mattock so that bevel is 3/8-inch to 1/2-inch deep on both sides.

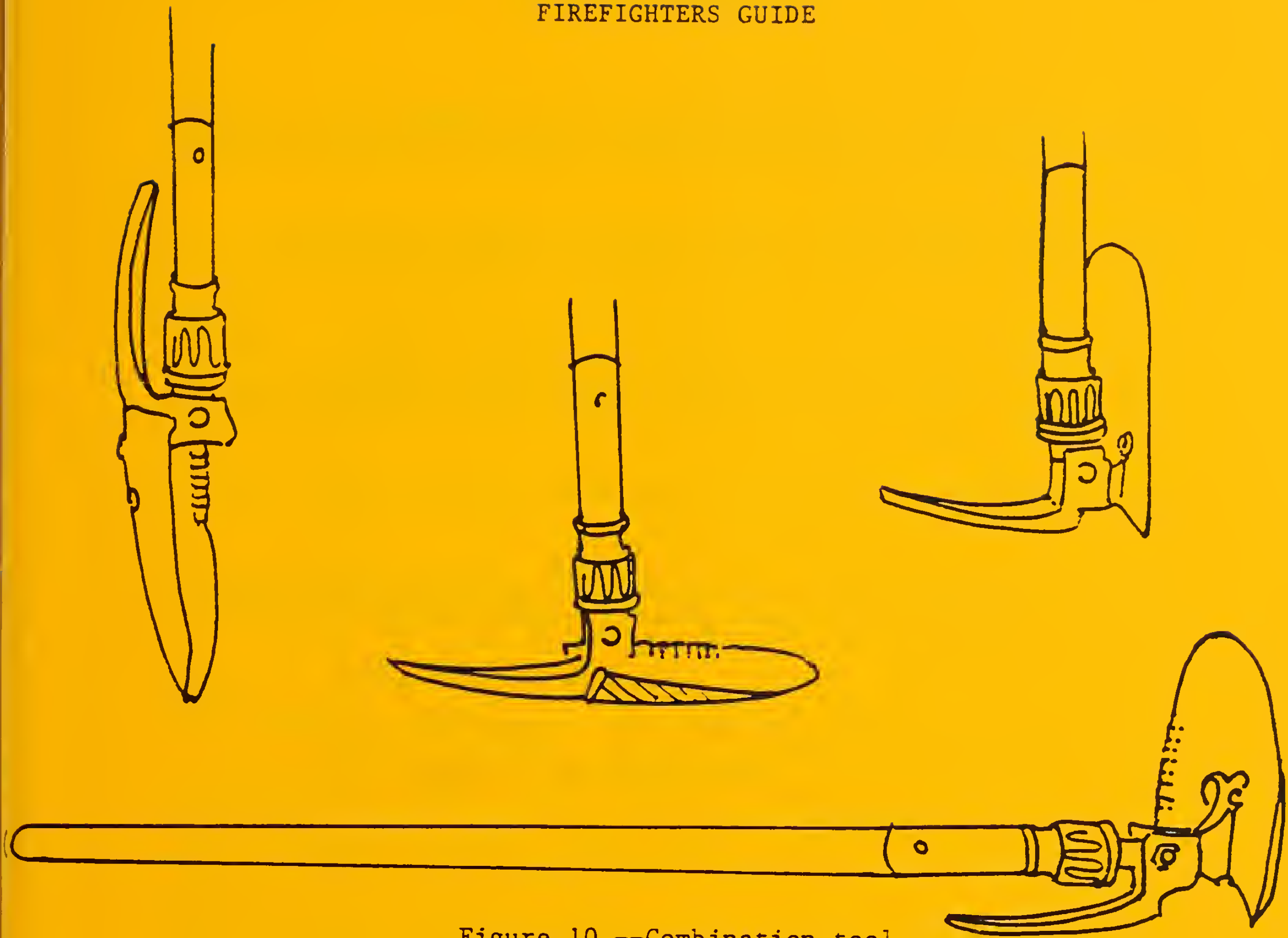


Figure 10.--Combination tool.

1. Sharpening.

(a) Extend the pick and shovel.

(b) Lock securely in position.

(c) Sock the pick portion securely in the ground.

(d) Sharpen on the beveled edge with a flat file similar to a McLeod tool.

2. Care and Maintenance.

(a) Keep the handle clean.

(b) Keep the tool sharp.

(c) Don't use the pick as a pry tool.

(d) Carry the tool with the blade and pick in a folded position.

61.14 - Marking. To prevent theft and as a means of ready identification, all fire tools and equipment should be marked according to agency instructions.

61.15 - Rust Prevention. Axes, shovel, Pulaski, and similar tools.

Oronite priming solution or comparable material should be applied to metal parts of fire tools, such as axes and shovels to prevent rust when tools are not being used. Apply the solution with a small brush, being careful to apply only a light coating.

61.2 - Headlamps. Following are the main points to check when headlamp does not work:

If, after progressively trying a new bulb, fresh batteries, checking all connections, and increasing the tension of spring in cap, the headlamp does not work, check the cord for visible breaks.

If no damage to the cord is apparent, the switch is probably defective. Repair by replacing case. Destroy old case.

To prevent battery drain during storage, place a piece of cardboard or heavy paper on top of the upper batteries before closing the case.

All lights should be given an operational check at the start of the fire season and following each time used. The batteries must be removed before storing lights after the fire season. New batteries should be installed as lights are issued for use. A new supply of headlight batteries should be obtained each season. This type battery deteriorates rapidly. Do not reply on last year's "leftovers."

61.3 - Backpack Pumps. In reconditioning a backpack pump, the following points should be checked:

If container leaks, the bag or tank may be patched with epoxy or plastic patching kits.

Hose connections should be tight. Replace leaky hose. Examine outlet tube and fittings for dirt, corrosion or damaged parts.

Some common causes of improper operations and remedies are:

1. The outlet tube may be corroded or be touching bottom of tank. It should be cleaned and reset.

2. The plunger barrel may be gummed up. Clean with solvent.

3. Special plastic rings and metal parts may be worn. These should be replaced in new model pumps. Light cup grease may be used as a lubricant. Old model pumps should be repacked with graphite lubricated wick type packing.

4. Barrel or plunger may be bent. Creases may result where the metal holding clips contact the tube of the pump. Pump must be replaced.

5. Quick-connect fittings should work freely and openings should be clean. Replace damaged parts.

A plugged nozzle is generally caused by some foreign substance in the tip. Remove nozzle and clean the tip with a small wire.

A nozzle leaking around the joint may be fixed by replacing the washer at the joint.

All pump parts must be thoroughly washed daily when chemical retardants are used. Some retardants corrode brass and aluminum.

61.4 - Canteens. Plastic canteens and waterbags are now the standard. They should be kept clean and sanitary. If kept filled, change water frequently. To cleanse, rinse the canteen with a tablespoon of baking soda mixed with a quart of water. If cap leaks, replace gasket or cap. Check and replace straps, if necessary. If canteen has been used for gasoline, oil, or liquid other than water, destroy it.

61.5 - Firehose

1. Storage. Firehose of all types should be kept rolled or folded in a cool, dry, ventilated, rodent-proof room. Special protection for lined hose is needed in high-ozone areas to prevent rapid aging. Avoid circulating unfiltered air through the storage area on high-ozone-concentration days.

Do not store damp or dirty hose.

Do not store with paints or oils, or near sharp cutting edges.

2. Cleaning. Clean hose after each fire.

Wash cotton-jacket or linen hose with plenty of clean water, using a broom or semistiff brush. Exceptionally dirty hose may be scrubbed with mild soap or detergents provided it is thoroughly rinsed with clean water after scrubbing.

Rubber-covered hose should be wiped clean with damp rag. Examine rubber for cracks, especially in high-ozone areas.

Drain hose after washing and dry thoroughly. Avoid exposure to hot sun for long periods.

3. Testing. Test all hose after use. Test all lined and rubber-covered hose at least once every other year.

All hose should be tested to withstand not less than 250 pounds per square inch of pressure. Higher test pressures may be established by some agencies, depending on pumper capabilities.

Test with a manual firehose test pump, a power-driven firehose tester, or an engine. Hold the pressure for 30 seconds.

4. Rolling Hose. Neatly rolled hose which can be quickly and easily put into service adds speed to hose lays. One way to roll it is this way:

Lay one hose length on the ground. Carry male end back over the hose to a point about 2 to 4 feet from the swivel (female) end. Roll from the loop end--not too tightly. Tie with large rubber bands (sections cut from inner tubes).

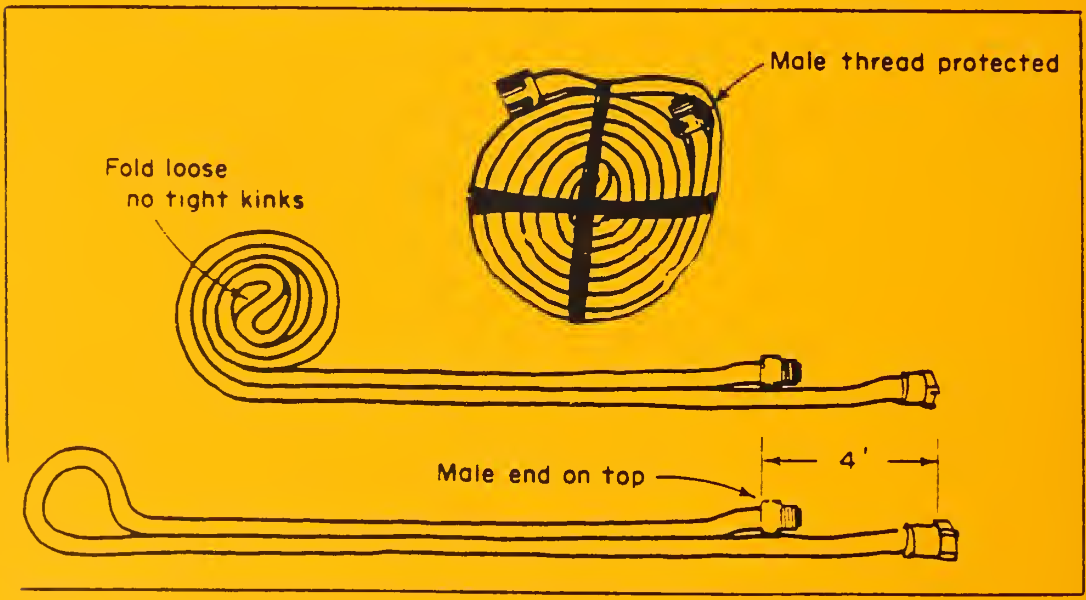


Figure 1.--Proper method of rolling hose.

61.6 - Firing Devices. Several types of firing devices are used in fire control. The most used ones are:

1. Fusee Torches. Must be stored in a dry place. Store in metal, or wooden box placed in a rodent-proof enclosure.

2. Drip Torch. Replace igniter if screen is ruptured, crushed, filler burned out or carbonized.

3. Propane Torches. Propane cylinders need protection from excessive heat and should be handled and stored in accordance with the local industrial safety codes.

4. Flamethrowers. Replace, repair or tighten leaky tanks, valves, ruptured hose, loose couplings and clamps. Keep tanks clean and wipe dry. Tanks should be emptied before storage.

61.7 - Power Saws. Repairing and reconditioning power saws requires special shop equipment and skilled mechanics. The chain may be sharpened and adjusted as needed using tools in saw kit.

62 - HEADQUARTERS AND CAMP EQUIPMENT

62.1 - Canvas Goods. Canvas mildews quickly under warm, dark, and moist conditions. The fabric may be weakened if stored on damp floors or poorly ventilated rooms. Destructive chemical action can be caused by air and moisture influenced by sunlight. Folding of heavy canvas may weaken the material, particularly if it is rigid from freezing or waterproofing treatment.

1. Tents and Flies. The more common preventive measures are:

a. Expose to the sun as little as possible. Tents should be taken down when not needed.

b. Canvas should be thoroughly dried before storing.

c. Torn canvas should be repaired promptly. Neglect will usually result in complete loss. Flexible canvas-patching compound is available commercially and can be used effectively to form a water-tight seal over small holes or tears.

d. Fold to protect wearing surfaces: (1) lay tent flat; (2) fold ends square with sidewalls; (3) fold roof flat over sidewalls; (4) fold again from top edge toward bottom. Continue to fold until width of fold is not greater than height of sidewall, then roll or fold to desired shape.

Folded this way, the roof, the most important part, is protected by the sidewall and only the lower part of the sidewall is exposed to wear and tear in storage or shipping.

e. Store canvas on racks or ventilated platforms or hang it up. Do not leave it on the floor.

f. Protect it from rodents.

2. Knapsacks, Packboards, and Field Packs. Knapsacks and canvas covered packboards are subject to mildew. They should be thoroughly dried and checked for damaged sacks, shoulder straps, and buckles. Repairs should be made prior to storage. The Firefighters Field Pack is an improved load carrying system designed specifically for wildland firefighters. It provides a convenient way to carry lunches, water, fire shelters, first aid kits, and headlamps while fighting fires. The nylon material requires less care than canvas items.

3. Canvas First Aid and Weather Belt Kits. These items are subject to mildew and should be treated in the same manner as other canvas goods.

62.2 - Leather Goods. Leather goods should be kept clean and pliable for maximum life, serviceability, and good appearance. A light treatment of Neat's foot oil rubbed on with a cloth once a year is good practice. Any leather article will mildew if kept in a warm, damp, dark place. To prevent mildew, keep the leather in a well-ventilated and dry place. If mildew occurs, wash off with a moist cloth. Dry the leather afterwards. Do not use preparations designed to prevent mildew. Soak brittle leather in clear water until soft, then wrap it in burlap or porous cloth for 24 hours. The following day, treat the damp leather with appropriate grease or oil. If the weather is hot and dry, thoroughly wet the burlap or cloth to make sure the leather will be damp at time of oil treatment.

62.3 - First Aid Supplies. Most first aid supplies deteriorate in storage. Adhesive tape loses its stickiness, aspirin tablets and insect sting medication their effectiveness, and some antiseptics evaporate. Crew-size kits should be checked at least annually, and unserviceable supplies replaced. Use latest standard lists.

62.4 - Gasoline Lanterns. Each lantern should be checked prior to the season of use, and after each time of use. Use of white gasoline, and a filter funnel when filling will prevent most of the customary troubles. Extra mantles and generators should be kept with each lantern. Also, a lantern wrench should be available. Do not store lanterns with fuel in tank.

FIREFIGHTERS GUIDE

1. Repairing. The most common troubles and remedies are:

Dirty gasoline--remove dirt from container. Refill with clean white gasoline.

Plugged generator tip--replace or clean with fine wire.

Broken mantle--replace.

Pump will not work--drop of oil or replace gasket.

Leaky filler cap--replace gasket.

Broken check valve--replace valve.

Bowl broken at seams--discard. Do not try to solder.

Leaky generator valve--replace.

2. Precautions. In use of gasoline lantern observe the following:

Fill bowl only 3/4 full of white gasoline to allow space for pumping air.

Heat the generator with a match and turn on gas only after the lantern has started to generate.

Fill lantern outdoors, using small filter funnel to avoid spilling gasoline.

Never fill around open flame. Use flashlight for light when filling at night.

After filling, wipe the lantern carefully. Wait five minutes before lighting to allow fumes to dissipate.

Never replace the filler plug by a cork or homemade plug.

Leave top of lantern and globe on when in use.

Place or hang sufficiently far from walls or ceiling to prevent starting fires.

62.5 - Sleeping Equipment

1. Paper Sleeping Bags. These disposable bags are usually issued to crews on project fires. They should be kept dry. After use they should be disposed of properly.

2. Cotton and Wool Blankets. These items should be laundered or dry cleaned after use. Store so they are protected from moths and rodents.

3. Nylon, Polyester and Down Sleeping Bags. At the end of the season or use by each person, these should be dry cleaned or laundered. They should be stored loosely packed, and protected from rodents.

63 - PROTECTIVE EQUIPMENT AND CLOTHING

1. Hard Hats. Replace damaged suspension harness and clean, sterilize or replace headband when necessary. Sterilizing can be accomplished by washing with detergent or saddle soap followed by exposure to sun for 10 hours.

2. Flame Resistant Shirts and Trousers. They may be laundered or dry cleaned.

3. Forest Fire Shelter. Shelters should not be removed from sealed container unless intended for actual use. Opened shelters should be discarded or used only for training purposes.

4. Gloves. Inspect for holes or tears, and discard if damaged. If wet, lay out flat to dry.

64 - STORAGE.

Fire equipment and supplies should be stored in a dry, well ventilated room or building.

Equipment should be grouped by types. Space should be left between groups for air circulation and fire protection. Miscellaneous small items should be stored where clearly visible. Where necessary to store in drawers or bins the outside should be labeled to show contents.

CHAPTER 70 - FIRE MANAGEMENT TERMS

Position titles correspond to those used in the Incident Command System.

Air attack supervisor. A person responsible to the air operations branch director for tactical deployment of aircraft for fire control.

Air freight. All items for transport and delivery entirely by aircraft from airfield to airfield, or heliport to heliport.

Air operations director. The person primarily responsible for preparing the air operations portion of the incident action plan. Also responsible for providing logistical support to helicopters operating on the incident.

Air tanker coordinator. A person responsible to the air attack supervisor for supervising operation of air tanker airplanes in accordance with instructions from air attack supervisor.

Alidade. A straightedge equipped with sights; an essential part of a device for locating fires. See Firefinder.

Anchor point. An advantageous location, usually a barrier to fire spread from which to start constructing fireline. Used to minimize the chance of being flanked by the fire while the line is being constructed.

Attack time. Date, hour, and minute the person who does the first suppression work on a fire starts to it.

Available fuel. The portion of the total fuel that actually burns.

Azimuth. Direction from a point, measured in degrees clockwise from true north.

Azimuth circle. A circle graduated in degrees in a clockwise direction.

Back azimuth. Azimuth plus 180°; direction opposite to azimuth.

Back-burn. Used in some localities to specify fire set to spread against the wind in prescribed burning. Also called backing fire.

Backfire. A fire set along the inner edge of a control line to consume the fuel in the path of a forest fire and/or change the direction of force of the fire's convection column. Note: Doing this on a small scale and with closer control, in order to consume patches of unburned fuel and aid control line construction (as in mopping up) is distinguished as burning out.

Barrier. Any obstruction to the spread of fire. Typically, an area or strip devoid of flammable fuel.

Berm. Outside or downhill side of a ditch or trench.

Blind area. An area in which neither the ground nor its vegetation can be seen from a given observation point under favorable atmospheric conditions.

Blowup. Sudden increase in fire intensity or rate of spread sufficient to preclude direct control or to upset existing control plans. Often accompanied by violent convection and may have other characteristics of a fire storm.

Breakover. A fire edge that crosses a control line or natural barrier intended to confine the fire. The resultant fire. Also called slopover.

Broadcast burning. Intentional burning in which fire is intended to spread over all of a specific area within well defined boundaries.

Brush. Shrubs and stands of short scrubby tree species that do not reach merchantable size. (Not a synonym for Slash or Reproduction.)

Buildup. 1. Cumulative effects of drying (during a preceding period) on the current fire danger. 2. Acceleration of a fire with time. 3. Increase in strength of a fire control organization.

Burning conditions. The state of the combined factors of environment that affect fire in a given fuel association.

Burning index. A number related to the contribution that fire behavior makes to the amount or effort needed to contain a fire in a particular fuel type within a rating area.

Burning index meter. A device used to determine burning index for different combinations of burning index factors.

Burning out. Setting fire inside a control line to consume fuel between the edge of the fire and the control line.

Burning period. That part of each 24-hour period when fires will spread most rapidly. Typically, this is from 10 A.M. to sundown.

Calculation of probabilities. Evaluation of all existing factors pertinent to probable future behavior of a going fire and of the potential ability of available forces to carry out control operations on a given time schedule.

Catface. A defect on the surface of a tree resulting from a wound in which healing has not reestablished the normal cross section. See Fire scar, Fire wound.

Cat line. A fireline constructed by a dozer. See Dozer line.

Causes of fires. For statistical purposes forest fires are grouped into broad cause classes. The nine general causes defined in the U.S. are: Equipment, Campfire, Incendiary, Debris burning, Lightning, Railroad, Smoking, Children, and Miscellaneous. See separate definition of each.

Chance. Conditions suitable for a given kind of operation, for example: gravity chance, water so located that it can be delivered by gravity to a desired point; pump chance, the quantity and location of water with respect to a fire that is suitable for power pumps.

Check line. A temporary line constructed at right angles to the control line, and used to hold a backfire in check as a means of regulating the heat (or intensity) of the backfire.

Checking station. A point on a main route of travel where traffic is checked and travelers instructed as a fire-prevention measure. Sometimes called registration station.

Class of fire (as to kind of fire)

Class A. Fire in solid fuels, including forest fires.

Class B. Fire in flammable liquids.

Class C. Fire in electrical equipment.

Class D. Fire involving certain combustible metals.

Class of fire (as to size of wildland fires)

Class A. A fire of one-fourth acre or less.

Class B. A fire of more than one-fourth acre, but less than 10 acres.

Class C. A fire of 10 acres or more, but less than 100 acres.

Class D. A fire of 100 acres or more, but less than 300 acres.

Class E. A fire of 300 acres or more, but less than 1000 acres.

Class F. A fire of 1000 acres or more, but less than 5000 acres.

Class G. A fire of 5000 acres or more.

Closed area. An area in which specified activities or entry are temporary restricted to reduce risk of person-caused fires.

Closure. Legal restriction, but not necessarily elimination, of specified activities such smoking, camping, or entry that might cause fires in a given area.

Coarse fuels. See Heavy fuels.

Cold trailing. A method of controlling a partly dead fire edge by carefully inspecting and feeling with the hand to detect any fire, digging out every live spot, and trenching any live edge.

Command post. The location from which all fire operations are directed. There is normally only one command post for each fire situation.

Condition of vegetation. Stage of growth, or degree of flammability, of vegetation that forms part of a fuel complex. Herbaceous stage is at times used when referring to herbaceous vegetation alone. In grass areas minimum qualitative distinctions for stages of annual growth are usually green, curing, and dry or cured.

Confine a fire. To restrict the fire within determined boundaries established either prior to the fire or during the fire.

Contain a fire. To take suppression action, as needed, which can reasonably be expected to check the fire's spread under prevailing conditions.

Control a fire. To complete control line around a fire, any spot fires therefrom, and any interior islands to be saved; burn out any unburned area adjacent to the fire side of the control lines; and cool down all hotspots that are immediate threats to the control line, until the lines can reasonably be expected to hold under foreseeable conditions. See Suppress a fire.

Control force. Personnel and equipment used to control a fire.

Control line. An inclusive term for all constructed or natural fire barriers and treated fire edge used to control a fire.

Control time. See Elapsed time.

Creeping. Fire burning with a low flame and spreading slowly. See Smoldering, Running, Spotting.

Crew boss. A person in supervisory charge of usually 5 to 20 firefighters and responsible for their performance, safety, and welfare.

Cross shot. Intersecting lines of sight from two points to the same object. Frequently used to determine the location of a fire from lookouts. (Cross bearing)

Crown fire. A fire that advances from top to top of trees or shrubs more or less independently of the surface fire. Sometimes crown fires are classed as either running or dependent, to distinguish the degree of independence from the surface fire. See Crown out.

Crown out. With reference to a forest fire, to rise from ground level and begin advancing from tree top to tree top. To intermittently ignite the crowns as a surface fire advances.

Danger class. A segment of a fire danger scale identified by a qualitative or numerical term.

Danger index. A relative number indicating the severity of forest fire danger as determined from burning conditions and other variable factors of fire danger. See Burning index.

Danger meter. A device for combining ratings of several variable factors into numerical classes or ratings of fire danger.

Detection. The act or system of discovering and locating fires.

Difficulty of control. See Resistance to control.

Direct attack. Any treatment of burning fuel, e.g., by wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel.

Discovery. Determination that a fire exists. In contrast to detection, location of a fire is not required.

Discovery time. See Elapsed time.

Dispatcher. A person who receives reports of discovery and status of fires, confirms their location, takes action promptly to provide the people and equipment likely to be needed for control in first attack, and sends them to the proper place.

Division. A unit established to divide an incident into geographical areas of operation.

Dozer boss. A person responsible for supervising one or more dozer operators and helpers to get efficient and productive use of the machines in constructing fireline or in mopping up.

Dozer line. Fireline constructed by a bulldozer.

Drift smoke. Smoke that has drifted from its point of origin and has lost any original billow form.

Drought index. A number representing net effect of evapotranspiration and precipitation in producing cumulative moisture-depletion in deep duff or upper soil layers.

Dry lighting storm. A lightning storm with negligible precipitation reaching the ground.

Duff. The partly decomposed organic material of the forest floor beneath the litter of freshly fallen twigs, needles, and leaves. See Litter.

Elapsed time standards. Maximum amounts of time allowed by administrative rule for given steps of fire suppression.

Equipment fire. A fire resulting from the use of equipment.

Escaped fire. A fire which has exceeded initial attack capabilities.

False alarm. A reported smoke or fire requiring no suppression; for example, brush burning under control, mill smoke, false smoke, etc. See False smoke.

<u>False smoke</u>. Any illusion likely to be mistaken for smoke, such as gray cliffs, vapor, dust from sheep driveway, or road dust or fog.

<u>Feeling for fire</u>. Examining burned material after fire is apparently out and feeling with bare hands to find any live coals.

<u>Fine fuel mositure</u>. The probable moisture content of fast-drying fuels which have a time lag constant of one hour or less; such as, grass, leaves, ferns, tree moss, draped pine needles, and small twigs.

<u>Fine fuels</u>. See Flash fuels.

<u>Fingers of a fire</u>. The long narrow tongues of a fire projecting from the main body.

<u>Fire analysis</u>. Process of reviewing the fire control action on a given unit or the specific action taken on a given fire in order to identify reasons for both good and poor results, and to recommend or prescribe ways and means of doing a more effective and efficient job.

<u>Fire behavior</u>. The manner in which a fire reacts to the variables of fuel, weather, and topography.

<u>Firebreak</u>. A natural or constructed barrier utilized to stop or check fires that may occur or to provide a control line from which to work. Sometimes called a fire lane.

<u>Fire control</u>. All activities to protect wildland from fire. (Includes prevention, presuppression, and suppression.)

<u>Fire control equipment</u>. All tools, machinery, special devices, and vehicles used in fire control, but excluding structures.

<u>Fire control improvements</u>. The structures primarily used for fire control, such as lookout towers, fireguard cabins, telephone lines, and roads to lookout stations, etc.

<u>Fire cooperator</u>. A local person or agency who has agreed in advance to perform specified fire control services and who has received advanced training or instructions in giving such service. Also called cooperator, firewarden, per diem guard, etc.

<u>Fire damage</u>. The detrimental effects of fire expressed in monetary or other units including the unfavorable effects of fire-caused changes in the resource base or the attainment of organizational goals.

Fire danger. Resultant of both constant and variable fire danger factors, which affect the ignition, spread, and difficulty of control of fires and the damage they cause.

Fire danger class. See Danger class.

Fire danger meter. See Danger meter.

Fire danger rating. A fire management system that integrates the effects of selected fire danger factors into one or more qualitative or numerical indices of current protection needs. See Fire danger.

Fire danger station. A specific location where certain basic weather elements affecting fire are measured.

Fire edge. The boundary of a fire at a given moment.

Fire effects. The physical, biological, and ecological impact of fire on the environment.

Firefighter. A general term for smokechasers, lookouts, fire patrollers, and others employed for prevention, detection, and suppression of fires.

Firefinder. A device or instrument used by lookouts to determine the horizontal bearing and sometimes the vertical angle of a fire from a lookout.

Fireline. The part of a control line that is scraped or dug to mineral soil. Sometimes called fire trail. See Control line.

Fire management. All activities required for the protection of burnable forest values from fire, and the use of fire to meet land management goals and objectives.

Fire pack. A one-person unit of fire tools, equipment, and supplies prepared in advance to be carried on the back.

Fire plow. A heavy duty share or disc plow designed to be pulled by either horses or tractors to construct firebreaks and firelines.

Fire-progress map. A map maintained on a large fire to show at given times the location of the fire, deployment of suppression forces, and progress of suppression.

Fireproof. 1. Not burnable. 2. To treat an area, hazard, road, etc., so as to reduce the danger that fires will start or spread, for example, to fireproof a roadside or campground.

Fire protection. See Fire control.

Fire retardant. Any substance except plain water that by chemical or physical action reduces flammability of fuels or slows their rate of combustion.

Fire scar. 1. A healing or healed injury or wound, caused or accentuated by fire, on a woody plant. See Fire wound, Catface. 2. The destructive mark made on a landscape by fire.

Fire season. The period or periods of the year during which fires are likely to occur, spread, and do sufficient damage to warrant organized fire control.

Fire storm. Violent convection caused by a large continuous area of intense fire. Often characterized by destructively violent surface indrafts near and beyond the perimeter, and sometimes by tornado-like whirls.

Fire suppression organization. 1. The management structure designed to carry out the suppression job. 2. All supervisory and facilitating personnel assigned to fire suppression duty.

Fire-tool cache. A supply of fire tools and equipment assembled in planned quantities or standard units at a strategic point for exclusive use in fire suppression.

Fire trail. See Fireline.

Fire warden. An officer in charge of fire protection in a given area.

Fire-weather forecast. A weather prediction specially prepared for use in forest fire control.

Fire-weather station. A forest meteorological station specially equipped to measure weather elements that have an important effect on fire control.

Fire wound. Fresh or healing injuries of the cambium of a woody plant caused by fire. See Fire scar.

Firing out. Also called burning out. The act of setting fire to fuels between the control line and the main fire in burning out operation. See Burning out.

First attack. The first suppression work on a fire.

Flammability. The relative ease with which fuels ignite and burn regardless of the quantity of the fuels. Preferred to "inflammability."

Flanking. Attacking a fire by working along the flanks either simultaneously or successively from a less active or anchor point and endeavoring to connect the two lines at the head.

Flanks of a fire. The parts of a fire's perimeter that are roughly parallel to the main direction of spread. See also Parts of a fire.

Flareup. Any sudden acceleration of fire spread or intensification of the fire. Unlike Blowup, a flareup is of relatively short duration and does not radically change existing control plans.

Flash fuels. Fuels such as grass, leaves, draped pine needles, fern, tree moss, and some kinds of slash which ignite readily and are consumed rapidly when dry. Also called fine fuels. See Heavy fuels.

Flashover. Rapid combustion and/or explosion of unburned gasses trapped at some distance from the main fire front. Usually occurs only in poorly ventilated topography. More commonly associated with structural fire behavior.

Foam. A chemical fire-extinguishing mixture. When applied it forms bubbles which greatly increase the mixture volume. It adheres to the fuel, and reduces combustion by cooling and moistening and by excluding oxygen.

Followup. The act of augmenting the first people who go to a fire by sending additional people or equipment to facilitate suppression. Sometimes called Reinforcement.

Forest fire. A wildland fire not prescribed for the area by an authorized plan.

Forest fire shelter. A personal protection item carried by firefighters which when deployed, unfolds to form a puptent-like shelter of heat reflective materials.

Forest protection. Prevention and control of any cause of potential forest damage.

Free-burning. The condition of a fire or part of a fire that has not been checked by natural barriers or by control measures.

Fuelbreak. A wide strip or block of land on which the native vegetation has been permanently modified so that fires burning into it can be more readily extinguished. It may or may not have firelines constructed in it prior to fire occurrence.

Fuelbreak system. A series of modified strips or blocks tied together to form continuous strategically located fuelbreaks around land units.

Fuel moisture content. The quantity of moisture in fuel expressed as a percentage of the weight when thoroughly dried at 212°F.

Fuel-moisture-indicator stick. A specially prepared stick or set of sticks of known dry weight continuously exposed to the weather and periodically weighed to determine changes in moisture content as an indication of moisture changes in forest fuels.

Fuel reduction. See Hazard reduction.

Fuel type. An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause a predictable rate of fire spread or difficulty of control under specified weather conditions.

Fuel type classification. The division of forest areas into fire hazard classes.

Going fire. A fire on which suppression action has not reached an extensive mopup stage.

Ground fire. Fire that consumes the organic material beneath the surface litter of the forest floor, such as, peat fire.

Hangover fire. See Holdover fire.

Hazard. A fuel complex defined by kind, arrangement, volume, condition, and location that forms a special threat of ignition or of suppression difficulty.

Hazard reduction. Any treatment of a hazard that reduces the threat of ignition and spread of fire.

Head fire. A fire spreading or set to spread with the wind.

Head of fire. The most rapidly spreading portion of a fire's perimeter, usually to the leeward or up slope. See also Parts of a fire.

Heavy fuels. Fuels of large diameter such as snags, logs, and large limbwood, which ignite and are consumed more slowly than flash fuels. Also called coarse fuels. See Flash fuels.

Held line. All worked control line that still contains the fire when mopup is completed. Excludes lost line, natural barriers not backfired, and unused secondary lines.

Helibase. A location within the general incident area for parking, fueling, maintenance and loading of helicopters.

Helijumper. A firefighter equipped and trained to jump from a helicopter to fight fire in areas where helicopters cannot land.

Helispot. A temporary landing spot for helicopters.

Herbaceous stage. See Condition of vegetation.

Holdover fire. A fire that remains dormant for a considerable time. Also called hangover fire or sleeper fire.

Hose-lay. The arrangement of connected lengths of fire hose and accessories on the ground beginning at the first pumping unit and ending at the point of water delivery. See Progressive hose-lay, Simple hose-lay.

Hotshot crew. An intensively trained firefighting crew used primarily in hand line construction.

Hotspot. A particularly active part of a fire.

Hotspotting. Checking the spread of fire at points of more rapid spread or special threat. Is usually the initial step in prompt control with emphasis on first priorities.

Incendiary fire. A fire willfully set by anyone to burn vegetation or property not owned or controlled by him and without consent of the owner or his agent.

Incident commander. The individual responsible for the management of all incident (fire) operations.

Indirect attack. A method of suppression in which the control line is located along natural firebreaks, favorable breaks in topography, or at considerable distance from the fire and the intervening fuel is burned out.

Inflammability. See Flammability.

Initial attack. The first suppression work on a fire. See First attack.

Jump spot. A selected landing area for smokejumpers or helijumpers.

Knock down. To reduce the flame or heat on the more vigorously burning parts of a fire edge.

Latitude. Angular distance, in degrees, minutes and seconds of a point north or south of the equator.

Lead plane. Aircraft flown to make trial runs over the fire and used to direct the tactical deployment of air tankers.

Legitimate smoke. Smoke from any authorized use of fire as in locomotives, industrial operations, permitted debris burning, etc.

Liaison officer. A member of the command staff responsible for interacting with representatives from cooperating and assisting agencies.

Lightning fire. A fire caused directly or indirectly by lightning.

Litter. The top layer of the forest floor, composed of loose debris of dead sticks, branches, twigs, and recently fallen leaves or needles, little altered in structure by decomposition. See Duff.

Longitude. Angular distance, in degrees, minutes and seconds of a point east or west of the Greenwich meridian.

Lookout. 1. A person designated to detect and report fires from a vantage point. 2. A location from which fires can be detected and reported. 3. A fire crew member assigned to observe the fire and warn the crew when there is danger of becoming trapped.

Lookout-firefighter. A person having the combined function of lookout and firefighter.

Lookout house. A building containing living quarters with walls largely of glass, on a tower or natural elevation to permit an unobstructed view.

Lookout observer. A person at a lookout station employed to detect and report fires. Called towerman in some localities with flat relief.

Lookout point. A vantage point selected for fire detection.

Lookout tower. A structure to enable a person to be above nearby obstructions to sight. It is usually capped by either a lookout house or observatory.

Leapfrog method. A system of organizing workers in fire suppression in which each crew member is assigned a specific task such as clearing or digging fireline on a specific section of the control line, and when that task is completed, passes other workers in moving to a new assignment.

Meteorologist. A person responsible for preparing and making available fire weather forecasts necessary for planned control of the fire.

Miscellaneous fire. A fire of known cause that cannot be properly classified under any of the other eight standard causes. See Causes of fire.

Mixmaster. A person responsible to the fixed wing base manager for providing fire retardants to air tankers as required.

Mopup. The act of making a fire safe after it is controlled, such as extinguishing or removing burning material along or near the control line, felling snags, trenching logs to prevent rolling.

Net value change. The sum of the changes, both detrimental and beneficial, resulting from a fire.

Nonstatistical fire. Any fire not posing a threat to the resources or property of the jurisdictional agency, whether or not action was taken by the agency.

(a) Fires that have gone out naturally.

(b) Railroad fires confined to the right-of-way which do not endanger protected land and are suppressed by railroad employees with or without agency help.

(c) Small fires resulting from legitimate slash, prescribed or debris burning operations when extinguished by the causative agent without use of other than project funds.

(d) Abandoned campfires which because of condition of forest fuels or weather conditions cannot spread, or are confined to improved fireplaces or stoves.

(e) Individual incendiary sets when all sets burn together and are suppressed as one fire. In this event all sets will be reported as one fire.

Individual lightning fires set at the same time in proximity to each other which burn together and are suppressed as one fire. In this event only one fire will be reported.

(f) Individual incendiary sets which are suppressed separately where less than 1/4 mile intervenes between any two adjacent sets. Only one fire will be reported for any such sets.

Individual lightning fires set at the same time in proximity to each other (less than 1/4 mile part), which are suppressed separately. Only one fire will be reported for any such sets.

(g) Burning buildings, automotive equipment, haystacks, sawdust piles, etc., which under the prevailing conditions, are not a menace to agency protected lands.

(h) Fires from any cause, confined to private lands, which do not endanger agency protected lands and are suppressed by landowners or others responsible for their suppression with or without agency aid.

See Statistical fires.

Normal fire season. 1. A season in which weather, fire danger, and number and distribution of fires are about average. 2. Period of the year that normally comprises the fire season.

Panoramic photograph. Photographs from a lookout point, with azimuth and vertical angle scales given for specific geographic features, to assist in locating fires with a firefinder.

Paracargo. Anything intentionally dropped or intended for dropping from any aircraft by parachute, other retarding devices, or free fall.

Patrol. 1. To travel a given route to prevent, detect, and suppress fires. 2. To go back and forth watchfully over a length of control line during or after its construction, to prevent breakovers, control spot fires, or extinguish overlooked hotspots. 3. A person or group who carry out patrol actions.

Piling and burning. Piling lopped slash resulting from logging, and subsequently burning the individual piles.

Plow line. A fireline constructed by a fireline plow, usually drawn by a tractor.

Power Saws. Gasoline-powered saw for cutting trees, logs, etc. A chain saw.

Preparedness. 1. Condition or degree of being completely ready to cope with a potential fire situation. 2. Mental readiness to recognize changes in fire danger and act promptly when action is appropriate.

Prescribed burning. Controlled application of fire to wildland fuels in either their natural or modified state, under specified environmental conditions which allow the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread required to attain planned resource management objectives.

Presuppression. Activities in advance of fire occurrence to insure effective suppression action. Includes recruiting and training, planning the organization, maintaining fire equipment and fire control improvements, and procuring equipment and supplies. See Prevention; Suppression.

Prevention. Activities directed at reducing the number of fires that start, including public education, law enforcement, personal contact, and reduction of fuel hazards.

Prevention guard. A firefighter who helps to prevent fires by contacting forest users and inspecting fire prevention measures and fire equipment of industrial operations on the forest. Also called prevention patrol.

Primary lookout. 1. A lookout point that must be manned to meet planned minimum visible area coverage in a given locality. For that reason, continuous service is necessary during the normal fire season and the lookout usually is not sent to fires. 2. Sometimes designated the person who occupies such a station, but primary lookout or observer is more specific in this sense.

Progressive hose-lay. A hose-lay in which double shutoff Y's are inserted in the main line at intervals and lateral lines are run from the Y's to the fire edge, thus permitting continuous application of water during extension of the lay.

Progressive method of line construction. A system of organizing workers to build fireline in which they advance without changing relative positions in line. There are two principal methods of applying the system:

(1) Work is begun with a suitable space, such as 15 feet, between people. Whenever one crew member overtakes another, all of those ahead move one space forward and resume work on the uncompleted part of the line. The last person does not move ahead until the work is complete in assigned space. Forward progress of the crew is coordinated by a crew leader. This method of organization is variously termed moveup, stepup, bumpup, and functional.

(2) Each person does one to several licks or strokes of work and moves forward a specified distance. The distance is determined by the number of people equipped with a given tool and number of licks needed per unit of line to complete the work for that tool. This method is termed one-lick.

Project fire. Usually refers to a fire requiring people and equipment beyond the resources of the protection unit on which it originates.

Protection boundary. The exterior boundary of an area within which a given agency has assumed a degree of responsibility for wildland fire control. It may include land in addition to that for which the agency has jurisdictional or contractual responsibility.

Pump chance. See Chance.

Rate of spread. The relative activity of a fire in extending its horizontal dimensions. It is expressed as rate of increase of the total perimeter of the fire, as rate of forward spread of the fire front, or as rate of increase in area, depending on the intended use of the information. Usually it is expressed in chains per hour or acres per hour for a specific period in the fire's history.

Rear of a fire. Portion of the edge of a fire that spreads slowest.

Reburn. 1. Subsequent burning of an area in which fire has previously burned but has left flammable fuel that ignites when burning conditions are more favorable. 2. An area that has reburned.

Recreation fire. A fire resulting from recreation use, except smoking.

Reinforcement. See Followup.

Relative humidity. The ratio of the amount of moisture in a given volume of space to the amount that volume would contain if it were saturated. The ratio of the actual vapor pressure to the saturated vapor pressure.

Resistance to control. The relative difficulty of constructing and holding a control line as affected by resistance to line construction and by fire behavior. Also called difficulty of control. See Resistance to line construction.

Resistance to line construction. The relative difficulty of constructing control line as determined by the fuel, topography, and soil. See Resistance to control.

Risk. 1. The chance of fire starting as determined by the pressure and activity of causative agents. 2. A causative agent. 3. A number related to the potential number of firebrands to which a given area will be exposed during the rating day.

Rough. The accumulation of living and dead ground and understory vegetation, especially grasses, forest litter, and draped dead needles, sometimes with addition of underbrush, such as palmetto, gallberry, and waxmyrtle. Most often used for southern pine types.

Rough reduction. Reduction of the hazard from the rough. See Hazard reduction, Rough.

Running fire. Behavior of a fire spreading rapidly with a well-defined head. See Smoldering, Creeping, Spotting.

Safety island. An area used for escape in the event the line is outflanked or in case a spot fire causes fuels outside the control line to render the line unsafe. In firing operations, crews progress so as to maintain a safety island close at hand, allowing the fuels inside the control line to be consumed before going ahead.

Safety officer. An officer responsible to the incident commander for the safety and welfare of all firefighting personnel.

Saw boss (Felling boss). A supervisory officer in a fire suppression organization responsible for the activities of saw crews (using hand or power saws) in cutting snags or logs on a fire or part of a fire.

Scorchline (Scorch height). Average heights of foliage browning caused by a fire.

Scout. A staff worker in a fire suppression organization assigned duties of gathering and reporting timely information such as existing location and behavior of a fire, progress in control, and the physical conditions that affect the planning and execution of the suppression job.

Scratch line. An unfinished preliminary control line hastily established or constructed as an emergency measure to check the spread of a fire.

Secondary line. Any fireline that is constructed at a distance from the fire perimeter concurrently with or after a line already constructed on or near to the perimeter of the fire.

Secondary lookout. 1. A lookout point used to supplement the visible area coverage of the primary lookout system when required by fire danger, poor visibility, or other factors. 2. Sometimes designates the person who occupies such a station.

Seen area. See Visible area.

Seen-area map. See Visible-area map.

Set. 1. An individual incendiary fire. 2. The point or points of origin of an incendiary fire. 3. Material left to ignite an incendiary fire at a later time. 4. Individual lightning or railroad fires especially when several are started within a short time. 5. Burning material at the points deliberately ignited for backfiring, slash burning, prescribed burning, and other purposes.

Simple hose-lay. A hose-lay consisting of consecutively coupled lengths of hose without laterals. The lay is extended by inserting additional lengths of hose in the line between pumps and nozzle.

Slash. Debris left after logging, pruning, thinning, or brush cutting. It includes logs, chunks, bark, branches, stumps, and broken understory trees or brush.

Slash disposal. Treatment of slash to reduce the fire hazard or for other purposes. (Preferred to Brush disposal.)

Sleeper fire. See Holdover fire.

Slopover. See Breakover.

Smokechaser. (See Firefighter.) A firefighter whose principal function is fire suppression.

Smoke haze. Haze caused by smoke alone and not by water vapor, dust, or other suspended matter.

Smokejumper. A firefighter who travels to fires by aircraft and parachute.

Smoking fire. A fire caused by a smoker's matches, or by burning tobacco in any form. See Causes of fires.

Smoldering. Behavior of a fire burning without flame and barely spreading. See Creeping, Running, Spotting.

Snag. A standing dead tree or part of a dead tree from which at least the leaves and smaller branches have fallen. Often called stub, if less than 20 feet tall.

Span of control. The maximum number of subordinates who can be directly supervised by one person without loss of efficiency. In fire suppression the number varies by activity, but is usually in the general range of 3 to 7.

Speed of attack. Elapsed time from origin of a fire to arrival of the first suppression force.

Spot burning. A modified form of broadcast slash burning in which only the greater accumulations are fired and the fire is confined to these spots.

Spot fire. Fire set outside the perimeter of the main fire by flying sparks or embers.

Spotting. Behavior of a fire producing sparks or embers that are carried by the wind and start new fires beyond the zone of direct ignition by the main fire.

Spread component. A rating of the forward rate of spread of a head fire.

Squad boss. A working leader responsible for efficient and productive work of usually 3 to 7 firefighters.

Standby crew. A group of firefighters especially organized, trained, and placed for quick suppression work on fires.

Statistical fire. A fire that is suppressed wholly or in part by agency employees or cooperators and on which suppression work is done either to prevent the fire from spreading or to burning over lands for which the agency assumes protection responsibility. See Nonstatistical fire.

Step test. A 5-minute test to predict a person's ability to take in, transport, and use oxygen (aerobic capacity), the most important factor limiting the ability to perform arduous work.

Stepup method. See Progressive method.

Strength of attack. The number of people and machines with which a fire is attacked.

Strike team. Specified combinations of the same kind and type of resources, with common communications, and a leader.

Strip burning. 1. Burning by means of strip firing. 2. In hazard reduction, burning narrow strips of fuel and leaving the rest of an area untreated by fire.

Strip firing. Setting fire to more than one strip of fuel and providing for the strips to burn together. Frequently done in burning out against a wind where inner strips are fired first to create drafts which pull flames and sparks away from the control line.

Suppress a fire. Extinguish a fire or confine the area it burns within fixed boundaries.

Suppression. All the work of extinguishing or confining a fire beginning with its discovery. See Fire control, Prevention, Presuppression.

Suppression crew. Two or more firefighters stationed at a strategic location, either regularly or in emergency, for initial action on fires. Duties are essentially the same as those of individual firefighters.

Suppression crew leader (Crew boss). A person in charge of a suppression crew.

Surface fire. Fire that burns surface litter, other loose debris of the forest floor, and small vegetation.

Swamper. An individual with an ax who cuts and clears away brush, and limbs small trees and down timber.

Task force. Any combination of resources with common communications and a leader.

Test fire. A controlled fire set to evaluate such things as fire behavior, detection performance, control measures.

Tool manager. A person responsible for maintaining and dispensing a continuous supply of handtools and equipment in serviceable condition, as needed by suppression crews.

Travel-time map. A map showing the length of time required to reach various parts of an area by a firefighter or crew from specified locations.

Trench. Formerly used as synonym for "fireline," which is preferred.

Undercut line. A fireline below a fire on a slope. Also called underslung line.

Variable danger. Resultant of all fire danger factors that vary from day to day, month to month, or year to year; for example, weather, fuel, moisture, foliage, growth and condition, variable person-caused hazard, and variable risks of ignition.

Vegetation stage. See Condition of vegetation.

Visibility distance. Maximum distance at which a smoke column of specified size and density can be seen and recognized as a smoke by the unaided eye.

Visible area. The ground or vegetation thereon that can be directly seen from a given lookout point under favorable atmospheric conditions.

Visible-area map. A map showing the specific territory in which either the ground surface or the vegetation growing thereon is directly visible, to practical distances, from a lookout point.

Water-supply map. A map showing location of supplies of water readily available for pumps, tanks, trucks, camp use, etc.

Wetting agent. A chemical that reduces the surface tension of water and causes it to spread and penetrate more effectively.

Wet water. Water with added chemicals, called wetting agents, that increase its spreading and penetrating properties.

Wildfire. Any fire occurring on wildland except a fire under prescription.

Wildland. An area in which development is essentially nonexistent, except for roads, railroads, powerlines, and similar transportation facilities.

Wood cylinders. See Fuel-moisture-indicator stick.

APPENDIX A
HEAT STRESS

HEAT STRESS-WHAT IS IT?

Wielding a pulaski on the fireline or hiking a steep slope with a heavy load is demanding work any time. But in the heat-under a glaring sun or near a flame front-it is even tougher. Sometimes the body can't cope with this added heat burden. The results can range from minor muscle cramps to exhaustion to often-fatal heat stroke.

Because firefighting is hot work, it is vital that you understand heat stress, how it affects you, and more important, what steps you can take to avoid it.

Heat stress occurs when humidity, air temperature, radiant heat, and too little air movement combine with heavy work and clothing to raise the body temperature beyond safe limits.

Sweat, as it evaporates, is the body's main line of defense against heat. As sweat evaporates it cools the body. In high humidity, sweating becomes more intense but doesn't evaporate, so no heat is lost. When water lost through sweating is not replaced, the body's heat controls breakdown and body temperature climbs dangerously, subjecting the body to heat stress.

HEAT STRESS DISORDERS

Heat Cramps

These painful muscle cramps strike workers who sweat profusely in the heat and drink large volumes of water, but fail to replace salt lost in sweating. Maintaining proper salt balance in body fluids is important. An imbalance causes tired muscles to cramp.

To treat heat cramps, drink lightly salted water (less than 1/4 teaspoon salt per quart); tomato juice; or, if you prefer their taste, commercial "athletic" drinks. Static stretching exercises may relieve muscle cramps temporarily.

Heat Exhaustion

Heat exhaustion is characterized by weakness or extreme fatigue; unstable gait; wet, clammy skin; headaches; nausea; and collapse. It is caused by inadequate water intake, salt losses, or both. The fluid loss leads to a drop in blood volume that severely limits work capacity. Salt imbalance also reduces the working ability of muscles. Treatment includes rest in a cool place and drinking lightly salted fluids.

Dehydration Exhaustion

This form of heat disorder can occur after several days of work in the heat. If water losses are not replaced daily, progressive dehydration can severely reduce work capacity. Weight loss is the best indicator of progressive dehydration. A loss of 2 percent or more is accompanied by diminished work capacity. Exhaustion and collapse may follow weight losses exceeding 5 percent.

Treatment includes fluid replacement and rest until water losses are restored.

Heat Stroke

Heat stroke results when the body's heat controls fail. It is characterized by:

Hot skin (often dry).
High body temperature (106 degrees F or higher).
Mental confusion, delirium, loss of consciousness, convulsions, coma.

Heat stroke is a **medical emergency.** Send for medical help at once and begin treatment **immediately.** Brain damage and death may result if treatmentis delayed.

Rapidly cool the victim by soaking clothing with cold water and fanning vigorously to promote evaporative cooling. Continue until temperature drops. Treat for shock if necessary once temperature is lowered.

PREVENTING HEAT STRESS

It is not enough to know how to recognize and treat heat disorders. You must know how to prevent them. There are two keys: physical fitness and acclimatization.

Fitness

Maintaining a high level of physical fitness is one of the best ways to protect yourself against heat stress. The physically fit worker has a well-developed circulatory capacity, as well as increased blood volume, important in regulating body temperature.

Fit people work with lower heart rates and body temperature. They start to sweat at lower body temperatures.

Fit workers adjust, or acclimate, to work in the heat almost **twice** as fast as unfit persons. Fit workers lose acclimatization more slowly, and are able to reacclimatize rapidly when again exposed to the heat.

Unfit workers who are overweight are even more unsuited for work in the heat. They have more weight without much increase in surface area for sweat evaporation.

Acclimatization

The person acclimated to work in the heat runs less risk of heat stress. The body adjusts to hot work in 4 to 8 days by:

Increasing sweat production.
Improving blood distribution.
Decreasing skin and body temperature.
Decreasing heart rate (beats per minute for the same job may drop from 180 to 150).

Acclimatization may be hastened by taking 250 milligrams of vitamin C daily.

About 1-1/2 hours of work a day in the heat is enough to acclimatize to a specific combination of work and heat. It provides partial acclimatization to more severe conditions.

Adjust to hot weather activity gradually. Set a sensible pace, take frequent breaks, replace fluids, and don't expect full production for the first few days.

Acclimatization persists for several weeks, but a tough weekend (fatigue, alcohol) leads to some loss.

ON THE JOB

Your best defense against heat stress is knowing when it is likely to strike. Temperature and humidity are your best clues:

Is it hot-thanks to sun or nearby flames?
Is the air still, with no breeze for cooling?
Is sweat dripping off your body?
Are you breathless, dizzy, chilled, nauseous?
Is your heart pounding at a rapid rate?

If the answer is **yes** to **any** of these questions, **beware of heat stress.** Continue working hard without taking some precautions and you're prime target.

Specific Steps To Prevent Heat Stress

Replacing Fluids

Drink lots of fluids. During hotwork it's common to lose **more** than a quart of sweat an hour (about 1-1/2 percent body weight). In a hot, humid environment, sweat rates can approach 3 quarts an hour for short periods.

Maximum sweat loss is 8 quarts an hour for short periods. Maximum sweat loss in 8 hours is 8 to 12 quarts. Adequate replacement of water, salt, and potassium is vital to maintain your work capacity and to avoid heat cramps, heat exhaustion, or heat stroke.

To Prevent Dehydration

Drink 1 to 2 cups of juice or water before beginning work.
Take frequent drinks during each hour of work.
Drink as much as you can at lunch and at the evening meal.
Continue replacing fluids throughout the evening.

Remember, thirst always underestimates fluid needs. It's not easy replacing 8 or more quarts of fluid a day, but it must be done when performing hard work in the heat.

Replacing Salt

Replace salt lost through sweating. Fit, acclimated workers should be able to accomplish this with the saltshaker at meals. Unacclimated workers lose more salt in the heat so they should pay particular attention to salt replacement at meals and during work.

Don't overdo it though. **Avoid salt tablets.** Too much salt impairs temperature regulation, and heat disorders become more likely. Don't continue high salt intake when you return to a cool climate or less arduous job. Excessive salt can cause stomach distress, muscle soreness, fatigue, impaired heart function, high blood pressure, potassium loss, and mental confusion.

Replacing Potassium

Potassium can become depleted over extended periods of work in the heat, so make potassium-rich foods like bananas and citrus fruits a regular part of your diet. Another approach is to drink lemonade, or tomato juice, as well as water, in quantities comparable to the fluid loss. Commercial "athletic" drinks also help make up potassium losses.

Work habits

Pace yourself. There are individual differences in heat tolerance. If you push too hard to keep up with others, you may not last the whole work shift. When possible:

-Avoid working close to heat sources.
-Do hardest work during cooler morning or evening hours.
-Change tools or tasks to minimize fatigue.
-Take frequent 10- to 30-second rest breaks as you work.

Rest Periods

Work-rest cycles must be adjusted to prevent progressive fatigue. Shorter work periods and more frequent rest periods in a cool, shaded area minimize heat buildup and progressive fatigue. Experience has shown that when:

Your pulse rate is under 110 beats a minute (after 1 minute of rest)

or

under 100 after the third minute of rest

heat stress is unlikely during the workday. Ignoring these facts leads to fatigue and increased risk of heat disorders.

Protective Clothing

Modern flame-resistant clothing protects against sparks, embers, and brief exposure to direct flame. However, the fabrics that provide such protection reduce airflow through the garment that would normally cool the body by evaporating the sweat. Wear cotton T-shirts and undershorts to aid sweat evaporation. Avoid layers of clothing (vests, wool shirts, and so forth) that reduce airflow to the skin and add to the heat stress problem.

IN SUMMARY STRESSES ADD UP BECAUSE:

- -Physical work in a hot environment is far more demanding.
- -Heat stress and carbon monoxide (CO) have a greater combined effect than they do spearately.
- -Heat stress, fatigue, CO, and noise lead to more mental errors and a definite safety risk.
- -Physical work, heat stress, and prolonged work periods combine to pose a threat to health and safety.

Therefore: use caution and be aware of your working conditions, your body's reactions, and the reactions of those working around you under conditions that can result in heat stress.

APPENDIX B
PREVENTING AND TREATING POISON OAK AND POISON IVY

THE PLANTS

Poison oak or poison ivy afflicts outdoor workers in every State except Nevada, Alaska, and Hawaii. The plants are the greatest cause of workmen's compensation in the United States, and one of the leading causes of field injuries.

Poison oak and poison ivy plants can look alike, but their growth forms vary greatly. Poison ivy has a greater variety of leaf shapes than poison oak, although both have a characteristic triple leaf pattern. The plants can be shrubs growing 3 to 10 feet tall or long, woody, climbing vines. Poison ivy is often a plant growing less than a foot high. Poison oak is the name generally used in California, Oregon, and Washington for the shrub form.

Contact with either plant produces identical effects: itching, swelling, and painful blisters. A severe case can be disabling: itching and weeping blisters make sleep impossible; swelling of the face and eyes makes it hard to see; and when legs and groin are involved, it becomes difficult to walk.

No medicine can completely protect against poison oak/ivy rash. But by understanding the rash and how it is spread, effective measures can be taken to control it. Steroid gels can minimize discomfort and speed recovery.

HOW THEY POISON

The plants' sap contains an oil that causes an allergic reaction on the skin. Contacting the oil sets off a skin eruption that may vary from simple itching inflammation to water blisters.

The plants usually must be damaged-cut leaves, broken stems-to expose the sap. Leaves, stems, and roots contain the oil. The berries and pollen do not.

When the plants are burned, the toxic oil coats the soot, and this airborne material is dangerous. Inhaling this smoke can cause fever,

malaise, tracheitis, bronchitis, and a severe rash. Acute cases require hospitalization.

The rash can also be contracted by touching objects that have contacted the oil-clothes, tools, equipment, fingernails, even the skin itself. These carriers are called **fomites**. Smoke is a fomite. Animal fur is a fomite, too.

The oil loses its toxicity very slowly. Shoes or boots worn in a patch of poison oak or ivy and coated with the oil can remain contaminated for months-possibly years-and cause the rash on contact.

When the oil contacts the skin it penetrates and binds to skin cells. The body's immune system recognizes these cells as "foreign" and begins to destroy them, which results in the swelling, redness, and blisters. Basically, the reaction is similar to the way the body attacks and destroys cancer cells.

Excess oil that has not bound itself to the skin cells can be spread to other parts of the body. This is often seen as a rash appearing one place on the body the second day and another place on the third day.

WHO IS SENSITIVE TO POISON OAK/IVY

About half the people who contact the plant will develop a rash. Some people require more of the oil than others to produce a reaction.

Sensitivity can change with time. In general, persons repeatedly exposed to poison oak or poison ivy become more sensitive. They react to lower concentrations of the oil. Individuals who don't encounter these plants for several years become less sensitive. Also, people become less sensitive as they get older.

But these general rules don't always hold true. Persons who have always waded through patches of poison oak without effect can suddenly develop a severe rash after such contact. Yet, occasionally, after a serious bout of poison oak or ivy, a person becomes less sensitive.

PREVENTION

Education

The best way to prevent the rash is to recognize the plants and avoid them. But their appearance varies from region to region and season to season. Much of the spring and summer the leaves are a waxy green. They

may be yellow, red, or a deep maroon, as well. In autumn the foliage is a vivid red.

Seeing the plants in their natural surroundings is the quickest way to become familiar with them. Photos or drawings are a help. Workers who don't know how to recognize the plants should attend a safety session on poisonous plant identification.

Protective Clothing

Normal field clothing protects legs, feet, arms, and hands. But wrists, face, and eyes are often unprotected, so they are problem areas.

Wielding a pulaski or picking up brush exposes the wrists. Sleeves should be kept buttoned over gloves so wrists and arms are exposed as little as possible.

Protecting the face is harder. Oil that collects on the shirt sleeves can be spread to the face when wiping sweat from forehead and eyes. Wearing a terry cloth sweatband under the hardhat absorbs sweat and keeps it out of the eyes. Or a bandana can be tied around the forehead to collect sweat. It can be rinsed or wrung out periodically. Gloves should be kept away from the face.

Any type of protective clothing is better than none. But protective clothing has its drawbacks. If the oil gets on skin and in sweat, the clothing itself can spread the oil both directly and by promoting sweating. Clothing can also increase penetration of the oil into the skin. Oil that contacts the inside of the sleeves can be spread up the arms both by direct contact and by mixing with sweat.

Have clothing laundered as often as practical when working in areas where poison oak or poison ivy is common.

WASHING

The oily sap is marginally soluble in water-a little water spreads the oil, but a lot washes if off.

One of the best ways to prevent the rash is to wash the skin thoroughly with <u>cold water</u>. (Warm water allows the oil to penetrate more.) If this can be done in 1 to 3 minutes after exposure (exact time depends on individual sensitivity), the rash can be prevented. Even if it is too late to prevent the rash, excess oil should be washed off. Otherwise, it remains on the skin where it can spread. Liberal use of cold water on the

affected areas prevents this. Neither the red swollen area nor the blister fluid transmits the rash, only the oil can do so.

Using soap to wash the oil off the skin is controversial. Although better than water alone, soap removes the skin lipids (oils) that protect against absorbing the poisonous plant oil. These lipids take 3 to 6 hours to regenerate. If skin is washed with soap and water, then reexposed within this time, either from new contact or from poisonous oil spread from other parts of the body, a rash is more likely. So it's best not to use soap. Use lots of cold water instead.

Because the wrists, forearms, and face are areas of high contact, along with the hands, they should be washed thoroughly with cold water.

Besides washing skin carefully, clothes and equipment need to be washed. Remember, fomites are a major source of the rash.

Fomites should be washed **with soap** and water. Sleeves and gloves appear to be the primary fomites. Gloves should be rinsed in soapy water periodically to remove most of the oil.

Boots and tools are other important fomites. They can carry high concentrations of the oil and spread the plant poison. Wash them thoroughly.

TREATMENT MEDICATION

Topical Steroids

Potent steroid **gels** have been developed that effectively prevent the rash from developing or from getting worse once the rash has appeared. (Steroid creams, lotions, and ointments also are available, but gels are the most effective in quickly stopping the rash.) Workers exposed to poison oak or ivy should ask about topical steroid treatment.

These gels, like LIDEX (Syntex Labs, Palo Alto, CA), available by prescription in 10-to 15-gram tubes, are applied to the skin at the first sign of itching, redness, or swelling. They should be applied only to those areas exposed, and in moderation. The gel is rubbed into the infected area several times each day. Improvement can be seen in about 6 hours. The gel produces no adverse side effects as long as it remains local on the skin. Some of the gel is absorbed into the systemic circulation in amounts directly proportional to the area covered.

Systemic Steroids

These steroids are administered by injections and by pills. This more potent form of the medication is indicated when:

- The rash involves more than one-quater of the body.
- The face is red and swollen because of exposure in smoke.
- A very sensitive person contacts the oil and face or genitals begin to itch and swell.

Itching is usually the earliest sympton, followed by swelling and redness. Again, the earlier the steroids are administered the better. If a sensitive individual has been in a poison oak or ivy area and begins to itch over large areas of the body, systemic steroid therapy is indicated.

Systemic steroids can be administered by a physician either as tablets or injections.

Calamine Lotion

Calamine lotion is probably as good at relieving the itching as anything, apart from steroids. It's especially effective when applied to areas where blisters have formed, because it relieves the itching and absorbs the blister fluid.

Apply calamine lotion for symptomatic relief

Calamine lotion can be used along with steroid gels to relieve itching and improve the weeping blisters. It should not include additives such as Benadryl (antihistamine) or zirconium. Use calamine lotion instead of steroid gels when the area of contact is small, or when the rash is more than 72 hours old; steriod gels are not useful after that time.

PREVENTION SUMMARY

Know how to recognize the poison oak and poison ivy plants and how to avoid them. When the plants can't be avoided:

Wear protective clothing. Keep sleeves and cuffs rolled down and buttoned. Keep gloves on and shirt sleeves and gloves away from the face. Consider wearing a headband or bandana to absorb sweat.

Know which objects are most likely to carry the oil. Shirt sleeves, trouser cuffs, boots, gloves, and tool handles and surfaces are carriers.

Wash these items thoroughly with soap and water. After each fire in a poison oak or ivy area, launder clothes and sleeping bags.

Wash skin immediately with liberal amounts of cold water if contact is suspected. Avoid using soap. Washing the skin within 1 to 3 minutes after contact prevents the rash from developing. A lot of water washes off the oil, and a little water spreads it, so the best prevention is immediate washing with ample cold running water. (Sources include faucets, canteens, mountain streams, and water tanks.)

TREATMENT SUMMARY

Wash affected skin as soon as possible with cold running water. Any poisonous oil absorbed into the skin can be spread to other parts of the body. Washing off this excess oil prevents the rash from spreading.

Obtain steriods if itching begins. Both topical and systemic steroids depend on early use. It is critically important to request steroids at the earliest symptons, usually itching. Steroid gels applied to the skin will prevent the rash if used within the first 24 to 48 hours after contact. Because they work locally, they can be given in small doses without harmful side effects.

Persons particularly sensitive to the poisonous oil should obtain steroids (tablets or gels) from a physician <u>**before**</u> going into the field.

NOTE: This publication is adapted from **Poison Oak and Poison Ivy Dermatitis - Prevention and Treatment in Forest Service Work** by W.L. Epstein, M.D., and V.S. Byers, Ph.D., USDA For.Serv. Equip.Dev.Ctr.Pub.8167 2803, For.Serv.Equip.Dev.Ctr.,Missoula,MT 59801.

APPENDIX C
PERSONAL PROTECTIVE EQUIPMENT

The basic components include:

* Fire Shelter
* Hardhat
* Goggles
* Flame-resistant shirts and jeans
* Leather boots and wool socks

Together, these items protect firefighters from thermal and other job hazards while they work.

Fire Shelter

The fire shelter provides umbrella protection during fire entrapment and protects vulnerable airways and lungs, which the other components of the system cannot do.

Hardhat

With the possible exception of the fire shelter, the hardhats is the most important piece of wildland firefighting safety equipment. Hardhats have saved many lives and prevented serious injuries by protecting the wearer against falling trees, limbs, and rolling rocks.

Approximately 15 percent of the body's heat is lost through the head, so hardhats, which are cooler and lighter in weight, are preferred over helmets designed for structural firefighting. Special clips are added to attach goggles and night firefighting headlamps. As wildland firefighters confront more fires in areas where there are structures and associated electrical hazards, class B plastic hardhats, which provide electrical hazard protection,are preferred.

Goggles

From 1967 through 1971 eye injuries accounted for about 7 percent of all fire suppression injuries as a result of dust, smoke, brush and hot substances . Therefore, eye protection in the form of goggles, face shielded helmet or safety glasses, etc., is an an important component of the PPE system.

Flame-Resistant Shirts and Jeans

Flame-resistant clothing offer firefighters protection against flames, falling embers, coals and radiant heat.

Current clothing includes flame-resistant Nomex for shirts and jeans. Like most fabrics, Nomex burns if exposed to flame, but unlike them, it stops burning when removed. Instead of melting or burning to ash, it forms a char that continues to help protect the skin.

However, if flame resistant clothing is not available alterative clothing should be cotton-never synthetic.

What to Wear with Nomex

Clothes worn under Nomex shirts and jeans affect their protective qualities. Underwear of a polyester cotton blend is acceptable, but T-shirts and undershorts of 100 percent cotton are better. <u>All-synthetic underwear should never be worn.</u> Two layers of clothing, that is, Nomex plus underwear, provide better thermal protection. <u>But don't wear other work clothing under or over your Nomex</u> clothing. Doing so increases body heat, and puts an added load on the heat.

For colder weather and nights, jackets should be all wool, all cotton, or wool blends of at least 85 percent wool.

Flame-Resistant Gloves

Specially designed gloves are essential in protecting the firefighter's hands against blisters, scratches, small cuts, and minor burns during routine firefighting. But they also play a major fire protection role in the event of an aircraft accident or fireline entrapment. Reports from people entrapped in shelters emphasize the importance of gloves in holding down hot shelter material without getting burned.

Leather Boots and Wool Socks

Past fire entrapment investigations found that good quality leather boots traditionally worn for wildland firefighting provide adequate foot protection. All-wool or mostly wool sock offer added thermal protection. Wool wicks moisture from the skin. This helps keep feet cooler and drier, reducing the chance of blisters, a common firefighting injury.

Most agencies requires the firefighter to wear a lace-typed leather boot with at least an 8-inch top. Skid-resistant soles are required with a lug-type sole preferred. Slips and falls account for many firefighting injuries. One study over a 10-year period indicates that 17 percent result from slips and falls. So the importance of good skid-resistant soles cannot be overemphasized.

Chain Saw Chaps

Since all firefighters don't wear them, chaps have not been included as a component of the basic PPF system. However, due to the wide scale use of chain saws in firefighting, a brief review of this item is appropriate.

The outer shell is 11-ounce Cordura nylon, which cleans easily, resists tears and abrasions, and keeps the protective pads free of oil better than cotton canvas. The protective pads combine two layers of woven Kevlar with two layers of Kevlar felt. Kevlar is an aramid fiber like Nomex, but with more flame resistance. Moreover, because of Kevlar's cut resistance, it can slow and quickly jam the chain before cutters penetrate to the leg.

Quick-release buckles make the chaps easy to put on and take off. The chaps weigh 2 pounds and include a tool pouch.

Respiratory Protection

Even though the personal protective system doesn't include any kind of respirator the firefighter needs information, and a caution.

The fire shelter protects the firefighter's airways and lungs during fire entrapment. But what about protecting the working firefighter's respiratory system from smoke, dust, and hot gases?

For limited protection, firefighters have worn bandanas for years and are beginning to use disposable dust filters. When wearing bandanas or dust filters, they should be kept dry. In intense heat, as when

working against a hot flame front, there is a possibility that breathing hot, moist air through a wet dust filter or bandana can damage the respiratory system.

Furthermore, firefighters should not cover too much of the face. Cheeks and ears are excellent heat sensors. Covering them can lead a person to work too long in a hot situation. The result can be dehydration, heat stress, and prolonged elevated heart rate leading to premature fatigue, or worse.

NOTE:

Kevlar, Nomex, and Cordura are registered trademarks. Their use is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others that may be suitable.

United States
Department of
Agriculture

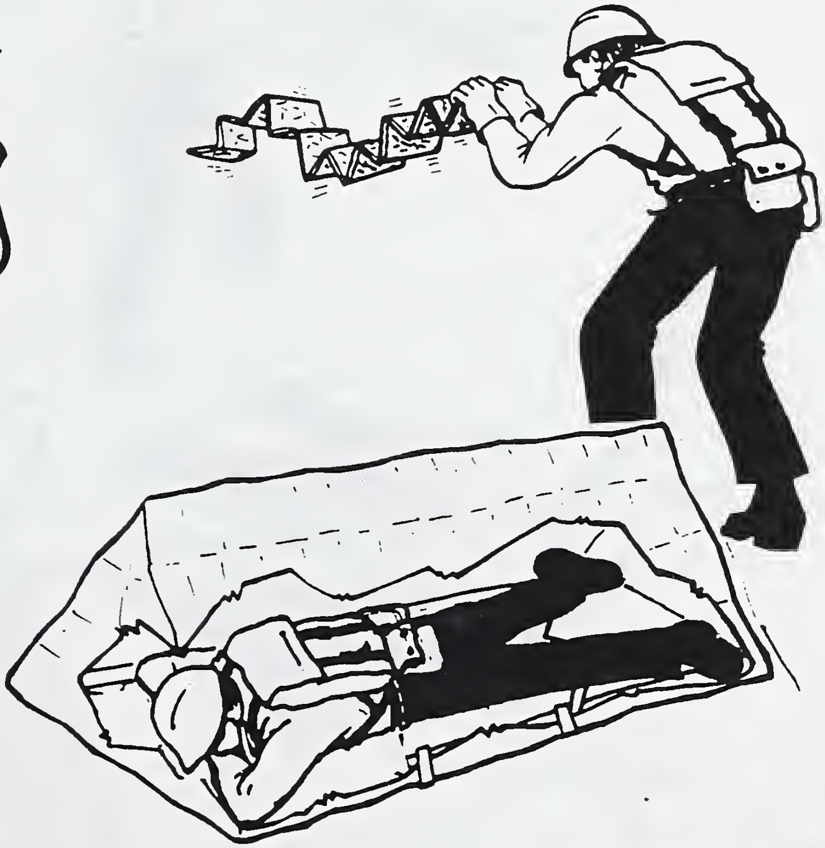
Forest Service

**Equipment
Development
Center**

Missoula, MT

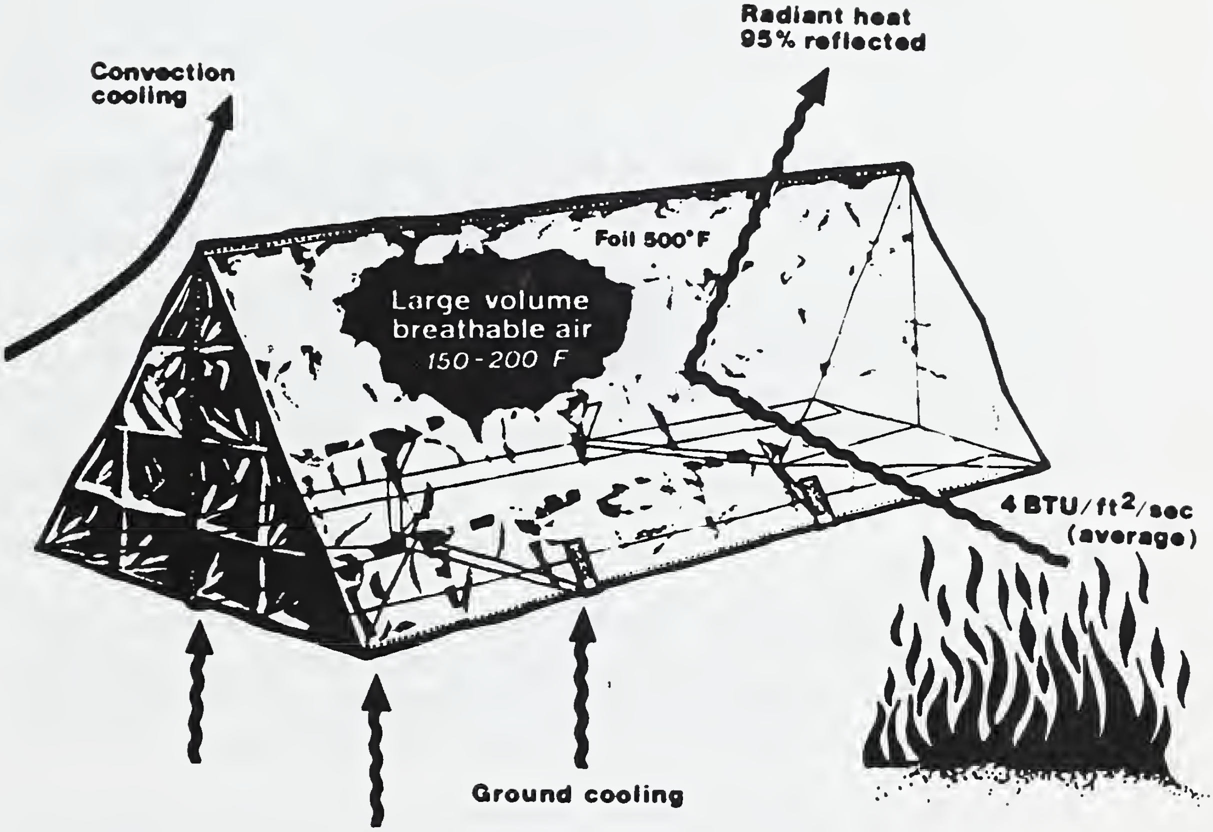
APPENDIX D

Your Fire Shelter



Revised May 1986
5100—Fire
8651 2501

Your Fire Shelter


Radiant heat
95% reflected
Convection
cooling
Foil 500°F
Large volume
breathable air
150-200 F
4 BTU/ft2/sec
(average)
Ground cooling

A Proven Lifesaver

Since the USDA-Forest Service made it mandatory to carry the fire shelter on the fireline, it has saved the lives of more than 140 firefighters. At the same time, it has prevented countless serious injuries and illnesses from burns and smoke inhalation.

The fire shelter saves lives by reflecting radiant heat. This means two things: There's a supply of more breathable air inside the shelter, and the shelter gives you a means to protect airways and lungs from flames and hot gases — the two leading killers in an entrapment.

But the shelter isn't fail-safe. Direct flame contact can destroy the shelter's protective properties. **Never go into a more dangerous area or situation because you're carrying the fire shelter.**

If entrapment seems likely, attempt proven escape procedures first. If escape plans fail or become impossible to execute, then use your shelter.

This booklet explains how the shelter protects. It stresses the importance of training and when and where to deploy the shelter. It tells you what to expect during entrapment. And it talks about inspection steps that will keep worn shelters off the fireline.

Designed to Protect

Because the fire shelter protects primarily by reflecting radiant heat, use instructions stress deploying the shelter as far as possible from fuel concentrations. Set up the shelter well away from both natural fuels and flammable equipment.

The shelter is aluminum foil bonded to fiberglass cloth with a nontoxic, high temperature adhesive. These are the best lightweight materials available for maintaining structural integrity in extreme heat and high wind.

The pup-tent shape lets you lie flat against the ground. This exposes less of the body to radiant heat and more to ground cooling. With your face pressed to the ground, you're in the best position to breathe cooler, cleaner air. The shelter's low profile exposes it to less turbulence and flame contact, while providing better cooling.

The foil reflects away 95 percent of a flame front's radiant heat. The remaining 5 percent is absorbed. This gradually makes it hotter inside the shelter. With prolonged exposure, temperatures can reach over 150° F. But you can survive such temperatures — dry saunas often reach 190° F. Stay calm and stay in your shelter.

The foil/cloth laminate may emit some smoke during prolonged exposure to heat. But it will be minimal, and it is nontoxic. Don't panic. The shelter will still protect you.

The shelter hold-down straps and perimeter skirt make it unlikely the shelter can be blown away if buffeted by high winds. The skirt also helps keep smoke and heat out.

Training

Training in shelter deployment and use is vital. It takes an untrained person several minutes to deploy and occupy a shelter. After three or four trials, this can be cut to 25 seconds or less. In an entrapment, a minute or two can be critical. Shelter deployment should be a mandatory part of your training.

Train wearing gloves and hardhat — wear web gear if you have it. The best training sites are in wooded areas with natural obstacles, so different site selections can be discussed.

Some entrapped firefighters suffered from claustrophobia while in their shelters. Fear of confined spaces and the dark combined with extreme heat, turbulence, and noise can cause panic. During training, spend enough time under a shelter to find out if you're claustrophobic. If you are, increase your shelter time gradually in stages. This should help you adapt.

Whether you're claustrophobic or not, in an actual entrapment, deploy your shelter near others. Being able to talk back and forth and reassure each other helps prevent panic.

Part of your training should include a mental imaging technique called visualization. Picture yourself in different entrapment situations. Think your way through all possible things that could happen. See yourself reacting correctly to each situation. The two most important actions are:

- Staying under your shelter.
- Protecting your airways and lungs by lying prone, face to the ground.

Think of visualization as a dress rehearsal. It's a form of practice that allows you to experience events before they happen. Images have a powerful effect on our bodies. The mind treats an imagined entrapment as if it were real. It is the most effective way to practice for an entrapment.

If you ever have to deploy your shelter, visualization makes it more likely that you'll react correctly, quickly, and without panic.

Visualization is a skill. To increase the effectiveness of your visualization, get into a state of relaxed attention:

- Relax — sit or recline comfortably with legs and arms uncrossed. You must learn how to relax, so perfect your relaxation techniques with practice.
- Breathe deeply — it has a calming affect and helps you relax.
- Concentrate on your images — if your mind wanders, gently bring it back to an entrapment situation.
- Believe, desire, and expect to respond correctly.
- Use all the senses — see the fire coming; hear its deafening roar; smell the smoke; feel the earth shake as you see and feel yourself correctly deploying your shelter.
- Be specific — images have a more powerful effect if they contain more details.
- Practice — it's better to rehearse shelter deployment and entrapment imagery 5 minutes a day for one week than 35 minutes at once.
- Let go — work with imagery, but don't force the process. Allow the images to work, and they'll be there when you need them.

For more realism in training, some crews occupy shelters near burning brush piles. This achieves realism, but dangers exist. Steps must be taken to ensure that a trainee doesn't panic, leave the shelter, and run into a fire. Realistic training requires new or fully serviceable fire shelters, not ones taken out of service. Safeguards should include fire suppression equipment and a radio link with the trainee.

A new training video tape titled "Your Fire Shelter" is for sale from the Boise Interagency Fire Center, Branch of Supply. Write or call the Branch of Supply for prices. Viewing this video, followed by repeated trial deployments of the shelter, and visualization practice are recommended for all those carrying fire shelters. Such varied training will build the confidence you need to trust your shelter.

Water Can Make the Difference

Water is vital in an entrapment. So always keep well hydrated when fighting fire. During your work shift, drink often, and keep your canteens filled. Off duty, drink lots of fluids. This way, should you ever become entrapped, you'll be adequately hydrated to promote sweating, the body's primary means of cooling. If entrapped, continue to sip water to replace lost fluids. Once your body stops sweating, a feeling of panic will follow. So stay well hydrated and always take canteens into the shelter.

If you anticipate entrapment or escape, **never wet yourself down**. Wet clothing conducts heat to the skin five times faster than dry clothing, making burns likely. In a fire shelter, wet clothing is doubly hazardous. It rapidly conducts heat if hot shelter material touches clothing. And it increases humidity. At equivalent temperatures, breathing moist, hot air will damage airways and lungs sooner than dry, hot air.

Deploying Your Shelter

The key is recognizing when deployment is your only option. When considering escape, remember, you can hold your breath for only about 15 seconds while running through flames or super-heated air.

Know how long it takes to reach your safety zone and get into your shelter. Crew bosses should identify likely escape routes and safety zones — the best fire shelter deployment areas — beforehand.

If you are part of a crew, your supervisor decides where and when to deploy. Follow orders. If you're not in a crew, or have become separated from it, you must rely on your own judgment.

Remember: Follow proven escape procedures first. Use your fire shelter as a last resort. But give yourself enough deployment time. Don't panic. Have confidence in the shelter and in yourself.

The shelter works best in light fuels such as grass, in which the flame front passes quickly. Try to pick natural firebreaks — meadows, creek beds, rock slides, the lee side of ridgetops and knobs, and depressions in the ground. Low spots will have less heat and smoke. Wide firelines like dozer lines, drainage ditches on the uphill side of roads, and burned over areas normally

make good deployment sites. In larger areas, don't let trucks, dozers, and other equipment occupy the best deployment sites.

Avoid heavy brush, trees with low branches, and logs and snags. Remember, fuels include gasoline cans, supply boxes, packsacks, and other firefighting gear. Keep away from narrow draws, chutes, and chimneys. They tend to funnel smoke, flames, and hot gases.

Some firefighters who have been trapped by fires say they deployed their shelters only reluctantly when entrapment appeared uncertain. They were concerned about the cost of opening a shelter that might not be needed.

Even though you should deploy your shelter only as a last resort, time is critical when entrapped. Play it safe. Give yourself ample time. Don't let the cost of opening a shelter become a factor in your decision. If the shelter isn't needed, carefully refold it and put it back in its case for reuse until you get a new one. Save the opened shelter for training.

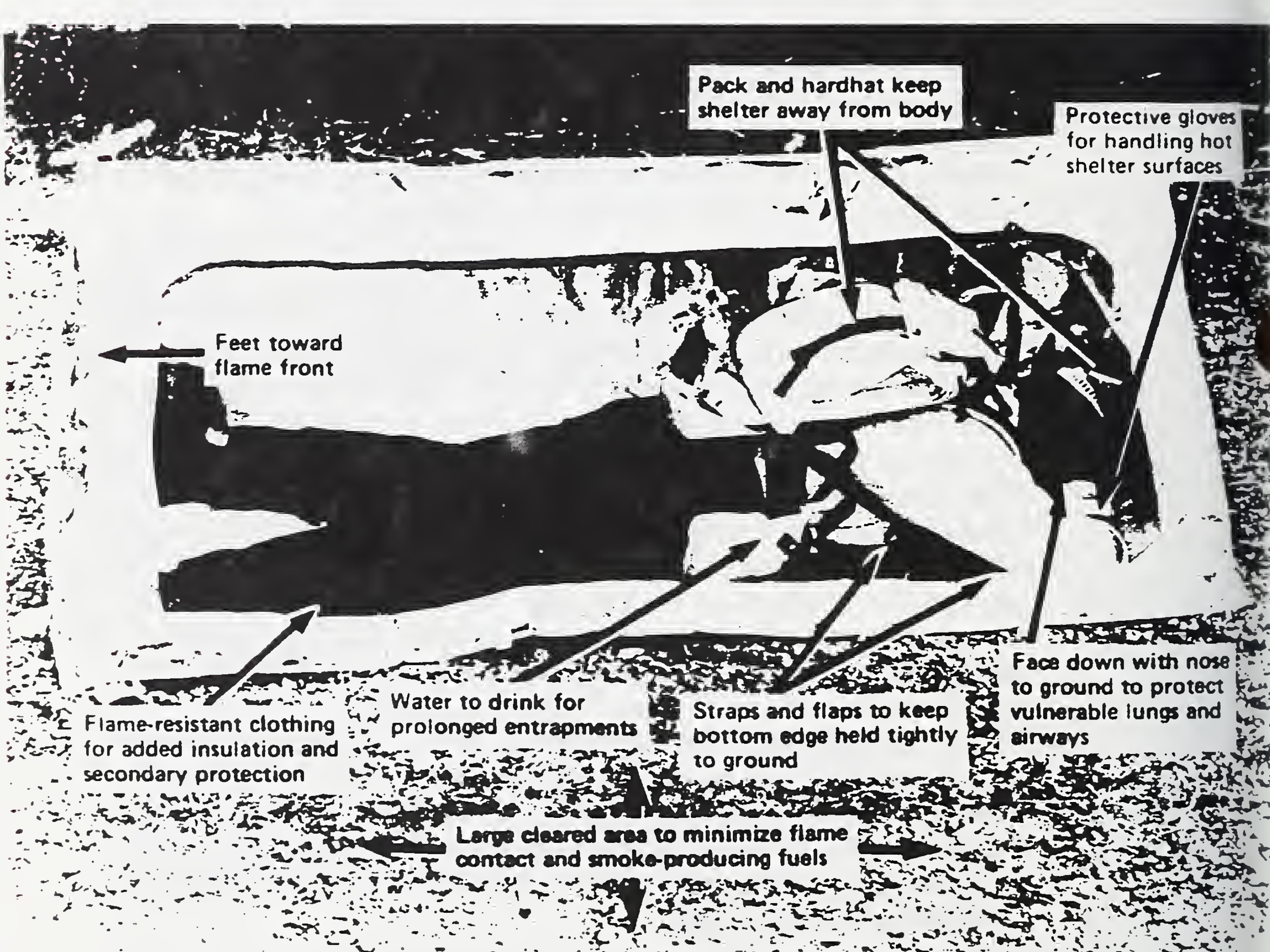
Once in a deployment area, pull the red tab on the vinyl bag. Don't wait until the fire front gets closer before deciding to open the shelter. Sometimes the pull tab separates from the tear strip. When this happens, a small hole is usually left in the bag. Use this hole to start the tear strip. If there is no hole, use a sharp object to puncture the vinyl along the tear strip. Insert a finger into the hole and pull down along the perforations. Another alternative is to cut open the end of the bag with a knife. Remove the shelter and open it up. You may have to remove your gloves to get the shelter out of the bag. New fire shelter bags have a large pull ring tab to allow opening while wearing gloves. If you remove your gloves to open the shelter, put them back on.

Now, select a specific deployment spot. It should be as free of fuels as possible. Begin scrapping away what fuels there are. Clear an area 4 by 8 feet (larger if you have time) down to mineral soil. A clean area minimizes flame contact with the shelter and the chance of fuels smoldering near by or even underneath the shelter.

While preparing a site, keep an arm or leg through a shelter strap. Otherwise, you may lose your shelter in the high winds generated by the flame front. With your shelter open and handy, if the fire front arrives before your spot is completely cleared, you can be under your shelter in a matter of seconds.

Leave handtools outside. Tool blades can cut shelter cloth. If you have web gear, wear it into the shelter. Remove any hazardous items like gasoline and fusees and toss them well away from the deployment area. The pack will help keep the shelter from touching you if turbulence collapses it. Take your canteens into the shelter. To prevent dehydration, continue sipping water when you're in the shelter.

Place your shelter so your feet are toward the oncoming flames. The end facing the advancing fire will become the hottest part of the shelter and easier to hold down with your feet.



Entrapment

Once you've prepared your spot, get into your shelter (wearing gloves, hardhat, and web gear) and stay there. Keep firmly in mind that you must protect your airways and lungs from the

fire's hot gases. Turbulence can lift a shelter edge, letting in hot gases. Flame fronts can generate winds of 50 mph or more, so you must hold the shelter down firmly. Gloves are critical. Without them you may burn your hands and be unable to hold down the shelter.

Keep your nose pressed to the ground as much as possible. There's usually about a 6-inch layer of cooler, cleaner air right at ground level. Then to help reduce the heat and smoke you inhale, breathe through a **dry** bandana — we'll talk about why it's so important to keep it dry in a moment.

If you have to adjust the shelter, remember, your lungs are vulnerable. Try not to breathe until your face is back against the ground.

During entrapment, talk to other trapped firefighters by radio or shout back and forth. If someone yells at you, try to let them know you're OK. If someone doesn't respond to your shouts, **do not** leave your shelter. Fire entrapment can induce panic, and some people may not answer until after the danger has passed. During very turbulent conditions, it will take all your effort to hold down the shelter. Also remember, at a fire's peak, the noise can be deafening, and you may be unable to hear anyone. Keep calm. As soon as the noise subsides, resume talking to each other.

You may want to move your shelter as the flame front changes position or to be closer to someone in trouble. Move by crawling turtle fashion, keeping the shelter edges close to the ground. Moving is risky. It exposes airways and lungs to hot flames and gases and allows the shelter to fill with smoke. There's a chance of losing your shelter to high winds because you can't hang onto it as well while moving. And you can do little to aid another person. Don't move unless it's absolutely necessary.

Never plan to share a shelter, unless someone is without one. In actual entrapments, two people have used one shelter. But the shelter is designed for one person. The extra space helps insulate you from the heat and minimizes body contact with hot shelter material. Sharing greatly increases your risk of injury. If sharing is unavoidable, lie face to face, noses pressed to the ground.

The fire shelter often has pinholes and cracks along its folds. Entrapped firefighters say that fire light entering these cracks

looks like hot coals or embers on clothing. These pinholes do not reduce your protection. No matter how big a hole or tear your shelter may have, you are still better off inside the shelter. Use proper care and routine inspection to control damage.

There is no fixed time to stay under your shelter. Don't move until the flame front has passed. A drop in noise, wind, heat, and change in color are usually tip offs that it's safe to leave the shelter. But play it safe. Stay put until you notice temperatures have cooled significantly or a supervisor tells you it's safe to come out. Leaving a shelter too soon can expose your lungs to super-heated air or dense smoke.

In a prolonged entrapment, temperatures within the shelter can range from 150° to 200° F. Studies indicate that by taking short, shallow breaths through the nose, air as hot as 400° can be inhaled at very low humidity for a brief time. So it's important to keep humidity low. **Never wet clothing or wear moistened face or respiratory protection like a wet bandana.** Instead, drink water so you continue to sweat, which aids body cooling.

Other studies conclude that such high temperatures, while tolerable for a time, can induce panic. Panic can cause people to leave their shelters and make a run for it — a far more hazardous gamble than staying put. Try to take advantage of that layer of fresh air that usually can be found at ground level. After the main fire front has passed, you can raise a side of the shelter — away from the hottest fire — a few inches to let in fresher, cooler air. Turn your face away from the side you lift, hold your breath, and lift slowly as a precaution against a blast of hot air.

In a long entrapment, as the foil continues to heat up, the inside surface of the glass cloth becomes hot enough to burn you. For added protection, you should be wearing hardhat, flame-resistant clothing, gloves, and web gear if you have it. Usually, the shelter fabric doesn't touch you. But entrapped firefighters tell of turbulent, fire-generated winds strong enough to blow the shelter against them. Gloves will let you push the cloth away from your body.

If the cloth temperature rises above 500° F, the adhesive starts to break down. Sometimes the glass/foil cloth separates. It can drape down and burn you. But more often it delaminates gradually, cooling first. The foil stays in place and continues to protect.

If flames contact the shelter, the glass/foil fabric heats up much more rapidly. If flame contact is prolonged, the aluminum foil can melt away, reducing protection. Even if this happens, it is still safer inside the shelter. Your flame-resistant clothing becomes your backup protection. It's even more critical to keep your nose pressed to the ground.

Direct contact with flames is the biggest threat to your shelter. It's vital to deploy it in a spot that offers the least chance of such contact.

Remember, once you commit yourself to the shelter, stay there. No matter how bad it gets inside, it's worse outside. If you panic and leave the shelter, one breath of hot gases could scorch your lungs. Suffocation will follow. Most firefighters who perish, die from heat-damaged airways and lungs not external burns. **Protect your airways and lungs at all costs by staying in your shelter.**

Should you ever be entrapped without your shelter, protecting your lungs and airways is your one chance for survival. Follow the guidelines for site selection and preparation for the shelter. Lie face down in the lowest depression on the site you pick. Try to dig a hole for your face and nose. Breathe through your nose. Mentally prepare yourself to stick it out, keeping your face pressed to the ground, no matter how painful it gets. It is your only chance.

Inspection

The shelter has an indefinite shelf life because its materials do not degrade in normal fire cache storage. Nevertheless, inspect new shelters. They could have been damaged in shipment or during storage. Shelters with the oldest manufacture dates should be issued first.

The aim of inspection is to ensure that only serviceable shelters reach the fireline. Don't assume a new carrying case contains a new shelter. Inspect it.

First inspect the vinyl plastic bag. Is it free of punctures and dents? Is the quick-opening strip unbroken and the tab intact? If you find a hole in the vinyl bag, or the quick-opening strip is broken but the shelter is still serviceable, the bag can be resealed. Simply remove any particles that could cause abrasion. Then reseal with a durable tape.

Abrasion is the most common shelter damage, and it can be spotted through the bag. Typically, the aluminum foil is rubbed from the fiberglass cloth. This occurs on the outer surface or outside edges. Remove the shelter from service if you see extensive edge abrasion.

If aluminum particles have turned the clear vinyl bag gray so you can't see the shelter, serious abrasion has occurred. Remove the shelter from service.

Debris in the bottom of the bag indicates excessive abrasion. Remove the shelter from service.

Look for tears along folded edges. Tears are most likely to occur at the two ends where all the sharp edges come together. Damage is less common along the wider folds. Remove shelters from service when tears exceed 1 inch long. Also look for dents or punctures in aluminum foil. These can be caused by rough handling; or by pressing the shelter against rocks, tree branch stobs, or other sharp objects. Remove from service shelters with dents or punctures in foil over 1 inch wide or with 1/2 inch or more of foil missing.

If you're unsure about the condition of a shelter, slit open the vinyl bag along the end opposite the red pull tab. Carefully examine the shelter by lifting the first several folds. Don't fully open the shelter. **A shelter deployed for inspection or demonstration should not be used on the fireline.** Check edges and outer surfaces for abrasion. These areas often wear as the shelter is carried. If serious abrasion exists, remove the shelter from service. If the shelter is undamaged, reseal the bag with durable tape.

You may want to determine the condition of a batch of shelters returned from the field. Pick a shelter that appears to be in the worst condition. Open and examine it against the light from the inside. You'll see small cracks and pinholes along the folds and seams. Many cracks and pinholes occur in the shelter fabric during manufacture, particularly in the sewing and folding steps. Dime size holes or smaller don't impair the shelter's ability to reflect away radiant heat. If holes are larger than dime size, inspect more samples to determine if the entire batch should be removed from service. Such defective shelters make excellent training aids. But they should be clearly marked "For Training Only" so none get on the fireline.

Care and Handling

Firefighting can be hard work and rough on equipment. So the fire shelter is expected to have a limited service life. But a little care can extend that life — even on the fireline.

The shelter is an important piece of protective gear. Treat it accordingly:

- Keep it away from sharp objects that may puncture it.
- Don't load heavy objects on top of it.
- Avoid as much rough handling as possible.
- Don't lean against objects when wearing the shelter.
- Don't sit on it or use it as a pillow.

Take only serviceable shelters to the fireline. Serviceability is determined by the inspection steps outlined above. We recommend inspection at the beginning and end of each fire season and whenever a shelter is carried on a person or in a vehicle for more than 14 days. Always inspect a fire shelter when it's issued to you. It's your life at stake.

A Final Word

Many firefighters once thought of the fire shelter as just excess baggage. Then they were trapped by wildfire . . . and survived thanks to their shelters. Now, they consider the fire shelter a vital safety item, and treat it that way. Do the same.

APPENDIX E
EXPOSURE TO CARBON MONOXIDE

Carbon monoxide is a natural by-product of the combustion of forest fuels and is emitted during prescribed fires and wildfires. Although carbon monoxide and its adverse effects have been known for over 2,000 years, it was not until recent years that agencies studied carbon monoxide and its effects on fire personnel. USDA Forest Service studies, supported by other studies, indicate that there are some conditions in which personnel, including support personnel, may occasionally be exposed to high levels of CO.

It should be noted that the degree of exposure to CO varies with each fire and is influenced by a number of environmental and human biological factors. CO could be a problem on some portions of some fires at certain times. It is not a problem on all portions of all fires at all times. Managers and crew bosses, following "common sense practices" can manage the problem and significantly reduce exposures.

PHYSIOLOGICAL AND BEHAVIORAL SYMPTOMS OF VARYING LEVELS OF CARBON MONOXIDE (CO) EXPOSURE.

What is Carbon Monoxide:

Carbon Monoxide is a gas "by-product" resulting from incomplete combustion of forest fuels. It is:

1. Tasteless

2. Invisible

3. Nearly Odorless

4. Slightly lighter than air

5. Highly toxic at high concentration levels

The highest concentrations of CO are at or near the "combustion zone." Generally it "co-exists" with smoke - where there is smoke - there's CO. In the body CO reacts with the blood's hemoglobin (oxygen carrying agent in blood). CO is "more easily absorbed" or preferred by blood than oxygen (250 x affinity over 02). The result of this is that CO

reduces 02 transport and blocks 02 utilization in the body. When oxygen is reduced, the cells of the body, including brain cells, become "oxygen starved." The effects of CO are more pronounced at higher altitudes where the 02 level is lower.

When we breath in CO our body functions are adversely affected. CO causes physiological changes which in turn cause negative behavioral changes. Carbon monoxide can be life threatening at high CO blood concentrations.

When we talk about CO in our blood, we use the term "Carboxyhemoglobin", (COHb), or "the amount of carbon monoxide in the oxygen carrying part of our blood." CO concentrations are expressed by percentage of CO in blood. (i.e., .05% or 10%). A "normal" level of COHb in our blood is .05%. The CO comes from the "normal air" we breath. As the level of COHb increases, due to above normal levels of CO in the air, the body is adversely affected. The changes are listed in the chart below.

1. 1.0% - No apparent effect.

2. 1.0-2.0% - Some effect on behavioral performance.

3. 2.0-5.0% - Central nervous system effects:

    a. Impairment of time interval discrimination.

    b. Visual activity (sharpness) and brightness discrimination.

    c. Psychomotor function (muscle coordination).

4. 5.0% - Negative cardiac (heart) and pulmonary (breathing) function change.

5. 10-20%+ - Headaches, fatigue, drowsiness, nausea, vomiting, dizziness.

6. 50-60% - Dizziness, intermittent convulsions.

7. 70-80% - Coma, cardio-vascular (heart/breathing) failure and death.

<u>Note</u>: Symptoms may be present at all levels slightly above or below those indicated.

The maximum "safe level" for fire personnel is considered to be 5% COHb. This figure is recommended by the National Institute for

Occupational Safety and Health and OSHA. This level allows fire personnel to "do the job with reasonable safety." It should be noted that smokers have higher COHb levels than non-smokers. Some smokers have COHb levels of 7-8% even before going into fire areas.

"How does CO actually affect the firefighter on the job? It has a negative affect on:

1. **Alertness**

2. **Vision** - difficult to discern colors, brightness.

3. **Time perception** - poor judge of time.

4. **Fatigue** - greater than expected for work production.

5. **Judgment** - often contrary to training and safe practice.

6. **Muscular coordination** - difficult in doing basic tasks.

Often we mistake CO poisoning for heat stress or excessive fatigue. These problems are often associated with the same environment and some of the symptoms are similar.

FACTORS WHICH AFFECT THE BODY'S RATE OF ABSORBING CO AND PURGING CO FROM THE BODY.

There are several human biological and environmental factors which affect the rate of CO absorption into the blood (COHb level).

The human factors include:

1. Physical fitness level - higher aerobic capacity (fitness level) lessens effect. The body is able to deliver more oxygen to the cells in a physically fit employee.

2. Physical activity level - arduous activity increases air (CO) intake and availability of CO to blood.

3. Length of exposure to varying concentrations of CO.

4. Smoking tobacco - COHb is significantly higher in smokers.

5. Cardio-vascular health - heart/breathing efficiency. People with coronary heart disease or other

cardio-vascular ailments will have greater adverse effects.

Environmental factors which influence CO absorption include:

1. CO concentration in the work environment.

2. Arduous work conditions.

   a. Steep slopes

   b. Difficult line construction

   c. Fast moving fire

   d. High temperatures

3. High altitude - especially 5,000' - 11,000' MSL

   a. Less 02 available with increase in altitude

   b. Less cardio-vascular efficiency

An individual's rate of CO absorption will vary according to the factors listed above and will vary from person to person. The absorption rate is generally rapid for the first 60 minutes, less rapid from one to eight hours, and then tends to level off after 8-10 hours of exposure. **The absorption rate is particularly high at high elevations and when the respiration (breathing) rate is rapid.** As we do the fire job, it is likely we will increase our COHb level. Fortunately, however, the effects of CO are reversible as CO is "naturally purged" from our body when we breath "uncontaminated" air. There are no residual or long-lasting effects except, perhaps, in people with cardiovascular problems.

How long does it take to reverse CO effects? Assuming the victim is placed in clean, uncontaminated air, the COHb half-life is 2 to 4 hours. There is a reasonable level of purging in 8 hours if the person had a moderate COHb level. The reversing of CO effects begins immediately when the person is introduced to "uncontaminated air."

THE WORK ENVIRONMENT WHERE CO CONCENTRATIONS ARE LIKELY TO BE PRESENT.

At different times of the day at different locations on a fire, or in the vicinity of a fire, the concentration of CO may vary. Several factors affect CO concentration. These factors include:

1. Completeness of combustion process as related to:

    a. Fuel type

    b. Arrangement of fuels

    c. Fuel moisture

    d. Heat intensity

2. Distance from "active combustion zone."

3. CO dissipation (dilution) by:

    a. Increased distance from "active combustion zone"

    b. Convection heating and CO rising because its lighter than air.

    c. Wind - over distance.

4. Combustion phases of fuels.

    a. Initial phase - usually highest concentration of CO.

    b. Mid-phase - moderate CO levels emitted.

    c. Mop-up phase - relatively high levels (incomplete combustion) of CO.

The highest, or most hazardous concentrations of carbon monoxide occur:

1. Near or immediately above active combustion zone.

2. Heavy concentrations of smoke.

    a. Inversion - stable air, or

    b. Downwind from fire

Personnel who operate mechanized equipment (power saws, pumps, etc.) may be exposed to not only CO from the fire but from the equipment they operate as well.

Topographic features often concentrate or channel CO and smoke. Likely places of high CO concentrations include:

1. Heads of canyons.

2. Ravines.

3. Saddles or passes.

4. Depressions or basins - especially during stable conditions or air inversions.

At night when downslope winds occur, the valley bottoms or basins may accumulate high concentrations of CO while the ridge tops may be relatively free of CO.

ACTIONS AND PLANNING WHICH MINIMIZE EXPOSURE TO CO.

Although it is impossible to completely eliminate some degree of exposure to CO, we can significantly reduce exposure to CO by following some practical guidelines. The following guidelines require evaluation and planning. Look for reasonable opportunities to reduce exposure to CO.

Tactics and Strategy Selection - When possible - select tactics and strategy that may reduce excessive CO exposure. Consider:

1. **Indirect attack** rather than a direct attack. An indirect attack places the crew further from the combustion zone, allows more opportunity for CO dissipation, reduces heat stress, and may possibly be a less arduous activity. A trade-off, however, may be that more volume of smoke/CO is produced which will affect other areas in the vicinity of the fire.

2. **Mop-up phase**

   a. Select the tactic - "quick mop-up or allow full burn out" whichever reduces the quantity and duration of CO most.

   b. Considering other hazards - if CO exposure is significantly less on some areas at night (fewer inversions, increased wind, etc), consider increased night operations.

3. **Crew Rotation** - moderate to heavy smoke (CO) concentration.

Rotate crews from areas of moderate-heavy smoke concentration to areas free of smoke or low smoke concentration. Order and assign additional personnel in order to facilitate crew rotation, allow for additional work breaks or allow longer periods of rest in order to purge CO from blood.

Rotate personnel (more often) who operate internal combustion engines (i.e., chainsaw, portable pump, engine operators). They may get "double dose" of CO.

4. **Communications**

a. Support and line personnel shall keep their superior informed of smoke/CO conditions in their work environment. Use this input in the planning process.

b. Alert your superior when personnel exhibit CO symptoms.

5. **Support Facilities**

Support facilities should be located in areas that are not affected by smoke (i.e., downwind of fire, inversion areas, or smog/pollution zones).

6. **Safety**

a. The Prescribed Fire Job Hazard Analysis should address CO exposure.

b. Prescribed and wildfire safety briefings should include CO exposure guidelines, reminders of CO symptoms, and likely areas of high concentration, etc.

c. Personnel who display adverse symptoms of CO exposure, heat stress, or fatigue should be restricted from duty until determined fit. This includes the operation of motor vehicles and aircraft.

d. Persons with known medical history or symptoms of cardiovascular problems or poor health will not be assigned to areas of heavy or moderate smoke/CO concentration.

e. Discourage tobacco smoking during assignments.

7. **Medical Planning and Emergencies**

a. Medical emergency planning should include CO exposure emergencies. A log of all persons treated for CO exposure, heat stress and fatigue should be kept.

b. Where abnormal or extreme CO, heat stress or fatigue appears to be a contributor to an accident, injury or

fatality, the Safety Officer will conduct or initiate an investigation to determine if, in fact, CO contributed to the situation.

EMERGENCY PROCEDURES WHEN PERSONS BECOME EXPOSED TO, OR SUFFER FROM, ADVERSE LEVELS OF CO.

In the event fire personnel display symptoms of adverse exposure to CO, you must be able to immediately respond to the situation. Under the situation listed below you should make the following response(s):

1. **Symptoms:** cardio-respiratory difficulties, or convulsions or coma.

   a. Alert superior - request Emergency Medical Technician or Paramedic immediately.

   b. Request medivac.

   c. Monitor patient closely and initiate CPR (cardio-plumonary resuscitation) in event of heart and/or breathing failure.

   d. Administer 02 (Oxygen), if available.

   e. Move patient to less contaminated or smoke-free area if practical (depending on patient's status).

2. **Symptoms:** Extreme fatigue, bad headache, nausea, vomiting and drowsiness.

   a. Alert superior - request rotation of crew or certain personnel.

   b. Closely monitor rest of crew for same symptoms.

   c. Move individuals or crew to less contaminated environment or smoke-free area; allow time to rest and determine condition.

   d. For those with "minor symptoms," take precautions to reduce CO intake (i.e., more work breaks, lower production rate, etc.).

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